ENGINEERING

OMIC REVIEW

ASHES OF BRILLIANCE
FRENCH ELECTRAMA

ISE RESEARCH

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LON AND TERYLENE
CONVEYOR BELTING

ESIGN PICTURE PAGE

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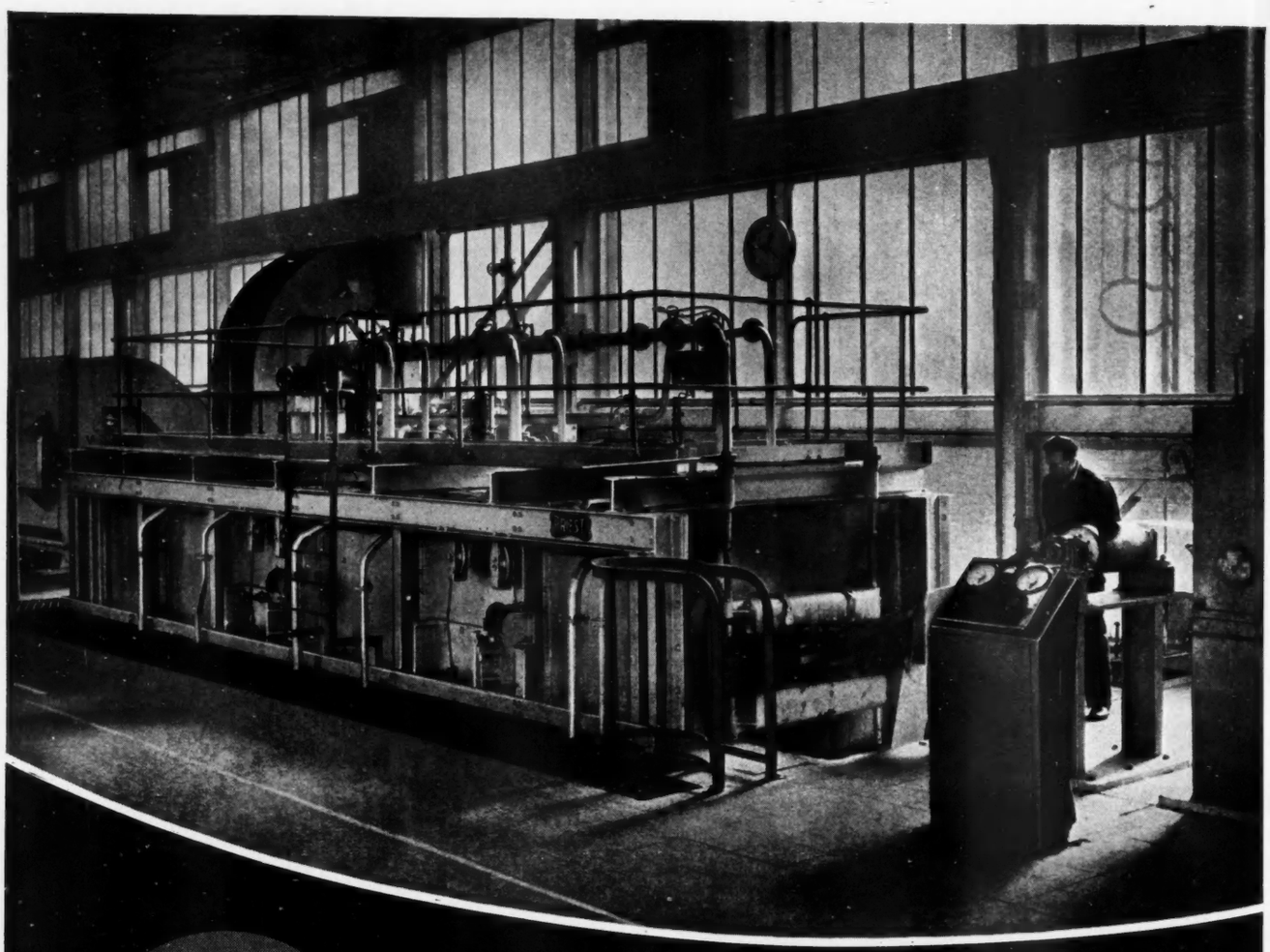

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ENGINEERING

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Education by Committee

THE vast increase in technical education facilities in the last few years has brought with it a corresponding increase in administration. It is fair to say that it has not brought with it yet anything like a corresponding increase in high quality teaching personnel or even in *esprit de corps* in the smaller and younger technical colleges. One of the dangers in developing technical education at the present time is that a surfeit of committee work will be created. If this should happen it will come about, not so much from a desire to form committees for their own sake as part of an administrative juggernaut, but from an excess of zeal in mobilising experience, finance and enthusiasm. This danger must be foreseen and forestalled.

One source of danger, if enthusiasm is not tempered by common sense, can be seen in the latest instruction issued by the Ministry of Education on what it calls " Governing Bodies for Major Establishments of Further Education." In this circular attention is drawn to the need to create governing bodies for further education institutions which will include representation from industry, commerce and from other appropriate interests in the locality. These bodies should, in the Ministry's view, have substantial powers clearly defined so that adequate contacts can be developed in the communities which the organisations serve. The Ministry is rightly anxious to create governing bodies having character and functions of a kind to attract intelligent people—people who can make a contribution at a high level towards running further education establishments. The Ministry goes on to say that these bodies should not be so large as to impede effective action, 20 persons being the number normally proposed.

These governing bodies should be given active and responsible parts to play, the Ministry goes on, and local authorities be given every encouragement to see that this is brought about. For example, the Ministry approves that these bodies should be empowered to spend funds within accepted limits without further reference back to local authorities. The governors should appoint the principal, teaching staff and a proportion of the non-teaching staff. While the local authorities should decide the general educational curriculum, the oversight of that curriculum and the running of the establishment should be left to the governors, the principal being responsible for day-to-day management and discipline. The Ministry advises that the principal should attend meetings of the governors. The Ministry also recommends that authorities should set up advisory committees for major departments which would provide a close link with industry and commerce.

These are broadly the recommendations of the Ministry of Education and their intention is entirely laudable. An effort is clearly being made to create enthusiasm and a corporate personality in further education organisation. It is all the more important, therefore, that committee work and the flow of paper should not get out of hand and smother the Ministry's good intentions. It is vital that these further education centres should be in close touch with industry and commerce but it must be clearly foreseen that the purpose of further education is to educate, and this involves neither cluttering up principals' time with an inordinate amount of paper work created by governing bodies, nor encroaching on teachers' time and energies with petty controls and administrative obstacles.

Committees of 20 can become immensely powerful, if sometimes also instruments of inertia. Committees rarely initiate anything, although they have a useful function to perform in rubber-stamping, in airing views and recording compromises. They can be the happy hunting ground of well intentioned amateurs, exasperating busybodies and axe-grinders from all walks of life, even from industry and commerce. They can burden executive officers' time with a massive flow of paper and a proliferation of subcommittees, which further add to the flow of paper, with their minutes and comments. The hospital service is an outstanding example of hard-worked officials being inundated and exasperated by masses of paper, paper which can never clear a hospital bed for a new case nor significantly reduce the queue in the out-patients' department.

The truth of Pope's remark that " whate'er is best administered is best " lies in the constant battle to keep administration tidy, simple and purposeful. The excellent intentions for the future organisation of further education will be realised only if these simple rules of administration (and engineering too) are fully borne in mind. By all means let local interest, especially from industry and commerce, be represented on their governing bodies but let it also be noted, reversing one of the great precepts of popular government, that there can be no representation without taxation.

The time of administrative officials and principals of colleges is taxed enough already.

Cover Picture.—*Recent proposals for communication systems based on transmission through long lengths of circular waveguide have stimulated research on methods of generating powers of the order of watts at the shortest possible wavelength. One approach, being studied in the Cambridge University Engineering Laboratory, involves the use of electron beams in crossed electric and magnetic fields, adjusted so that the cyclotron resonance is excited.*

(*Nurnberg photograph for* ENGINEERING)

Plain Words

Have you ever heard of JETS? If you are an American you may well have done so. I hadn't though, until the other day when my post brought me two slim booklets from the United States.

It will explain a lot if I tell you the import of the word. The initials stand for Junior Engineering Technical Society; originally they stood for Junior Engineering Training for Schools and it will further explain my interest if I quote the society's slogan: Better Talent for Engineering. The society was begun by Michigan State University in 1950 to stimulate interest in engineering and science among boys at high school, and set out to help the youngsters discover and compare their talents with the requirements of the engineering profession. The society has grown until there are now centres—known as chapters—all over the States, and a few outside as well.

The significant difference between the society's chapters and the school scientific society that I remember is the emphasis that is placed on the part a professional engineer can play. Right from the beginning there has always been an engineer adviser helping to guide each chapter. For some years now industrial concerns have contributed their support, not least by enabling senior staff, including chief engineers and employment supervisors, to help organise activities. The goal of professional engineering status has always been stressed to the youngsters and efforts made to promote and encourage good scholarship. Visits to local works and combined activities with branches of the professional institutions are a regular part of the chapters' business.

Now the society is on a national scale with nearly 400 chapters to its credit. A news-sheet is issued bi-weekly containing articles, bibliographies and reviews of recent publications. Special sheets are also sent out at short intervals, each covering a specific area in the field of engineering or physical sciences. A recent survey of members showed that 88 per cent plan to enter university, 63 per cent as engineers.

Here at home we need engineers as much as do the States. Heaven forbid that specialisation should be encouraged too soon, or that " handicrafts " should be thought to be a suitable introduction to engineering. A good sound grounding in engineering discipline is what is required. Our American friends seemed to have found a way. If anyone wants further details I'll be pleased to put them in touch.

CAPRICORN

Weekly Survey

Taking Sides with Cohen

The importance of cutting prices to raise real earnings and of stimulating investment to increase the output of the capital goods industries are the main themes of the third report of the Cohen Council on Prices, Productivity and Incomes. The present report has been assured of wider acceptance, thanks to the point which the trade cycle has reached. Previous reports were bound to be concerned with the problems of inflation and restrictions. On this occasion, when the country's economy is coming strongly out of recession, there is ample scope for discussing expansion and the advantages of driving home the gains achieved by a strong monetary and fiscal policy in the days of recession. Everything is getting better, and therefore everybody can hope for a little more. It is not surprising, then, that this year's report has had wider acceptance than its predecessors. Even the Labour Party has raised a faint cheer and only the Trades Union Congress continues to ignore the council's work.

Much of the report is taken up with the objective presentation of alternative ways of dealing with a national wages policy, the maintenance of real incomes and improvement in wage negotiating machinery. This approach is not surprising since Professor Phelps Brown, who has taken the place of Sir Dennis Robertson, the Cambridge economist on the council, is an authority on labour questions. There is a noticeable change of mood and emphasis in consequence in the report, which underlines what has been thought all along, that the economist plays a dominant role in the preparation of the report.

Up to a point an economic jurisdiction is no bad thing but it emphasises that the Cohen Council is bound to be subject to changes of fashion and political power. It may only be a question of time before the council has a left-wing economist and its annual report raises cheers from the trade unions and groans from the National Union of Manufacturers. It is difficult to avoid the conclusion that the council will always win the applause of those whose views it reflects and be anathema to those who think differently. Its influence on the cabinet of the day which through the Chancellor of the Exchequer makes fiscal and economic policy at Budget time must continue to be small.

Underground Gasification in India

A British engineer, Mr. Robert Langford, of Humphreys and Glasgow Limited is visiting India to discuss the introduction of coal gasification using methods developed in this country. Mr. Langford has been in charge of the gasification project for the National Coal Board at Newman Spinney. The new method there is showing encouraging results and the Board postponed closing down the pilot plant.

Satellites Play Many Parts

Satellites are nowadays tossed into space with the facility of a juggler. Of two launched recently, one is designed to transmit information, the other to demonstrate the possibilities of recovery. On 7 August a Thor-Able rocket carrying a 142 lb satellite was launched successfully from Cape Canaveral in Florida and according to the National Aeronautics and Space Administration it will remain in orbit for over a year. Its prime purpose is a radation study from an orbit varying between 150 and 23,000 miles from the earth. The satellite is a spheroid in shape and 26 in in diameter. In addition to the radiation studies it has instruments for 14 other major experiments. Its name of " Paddlewheel " comes from its four protruding paddles of power-generating solar cells.

By 9 August, when the satellite was on its fifth orbit, the Jodrell Bank radio astronomy station was turning the satellite's transmitter batteries on and off by means of a radio pulse from the radio telescope. The group tracking the satellite at Jodrell Bank includes six Americans working under instructions from their Space Administration headquarters in Los Angeles. Instructions when to switch the satellite's transmitters on and off were being sent from California to Jodrell Bank.

As prelude to man's first venture into space came the launching of an empty container similar to that which will carry the initial American astronauts into space. Fired by a reinforced Thor rocket, it carried a 300 lb capsule, which was to be ejected after 17 polar orbits of the earth. The capsule, which was covered by a heat ablation shield, was to be retarded on reentry into the atmosphere by retro-rockets and later brought to earth by parachute. Had it been successful, the experiment would have been the first recovery of an object from orbit. Unfortunately efforts to recover it from the ocean failed. The satellite, fifth to be named Discoverer, weighed 1,700 lb, and the weight of the complete two-stage vehicle at take-off was 110,000 lb (nearly 50 tons). The entire second stage, called Agena, was to go into orbit. Complete with liquid fuel it weighed 8,500 lb, diminishing to 1,700 lb on burnout.

Radio View of Southern Cross

A new radio telescope is to be erected in New South Wales for completion early in 1961. The project was made possible by gifts from the Rockefeller Foundation and the Carnegie Corporation in addition to those from the Commonwealth Government, Australian industry and private donors. The project was organised by the Commonwealth Scientific and Industrial Research Organisation of Australia who retained the London consulting engineers, Freeman Fox and Partners to prepare designs and specifications.

Two tenders were submitted from Britain, four from America and one from Germany. The German bid, which is considered to have been the lowest and most satisfactory, has been accepted, the German concern being Maschinenfabrik Augsburg-Nurnberg. A feature of the new telescope is that it will be fully steerable; the electrical drive and control gear will be manufactured by Associated Electrical Industries Limited as subcontractors. The telescope's parabolic radio " mirror " will be 210 ft in diameter and its surface accuracy and precision control and drive are expected to make it the most advanced of its kind in the world. One of the principals of control was devised by Dr. Barnes Wallis of Vickers-Armstrongs Limited.

Conference on Forest Techniques

A joint conference on the testing and application of forest machinery is to take place at Seattle, USA, in 1960. This conference will be held under the auspices of the FAO/ECE committee on forest working techniques and training forest workers. The joint committee was set up in 1954 by the United Nations Food

and Agricultural Organisation's European Forestry Commission and the Economic Commission for Europe's Timber Committee. Two previous sessions were held, one in France in 1955 and the other in Moscow in 1957. A third session was held this year in Norway.

Iron and Steel Prognosis

The annual report of the Iron and Steel Board for 1958 gives a review of the economic and technical developments in the iron and steel industry last year. So far as the prospect for 1959 is concerned, capacity is expected to be 24½ million tons of steel. It is expected that there will be a demand for 20 million tons this year, that is, 80 per cent of capacity, and raw material needs of the industry are being calculated on this basis. There is also comment in the report on the progress made in establishing and revising standard specifications for steel.

Way the Money Goes

Between January 1958 and July 1959 more than $2,500 million was transferred from the gold stocks of the United States to those of other countries. Much of this flow has been into the treasuries of Western Europe. In the first half of this last year there was much talk about the need to devalue the dollar and create conditions which would spread the world's stock of monetary gold more widely. The improvement in the economic position of Western Europe, and indeed of some other areas, in relation to the United States throughout 1958 made such steps unnecessary and no artificial stimuli have been necessary to induce a flow of gold from America to other countries. The result should be that the countries in Western Europe in particular should be able to contribute to the world's economic development programmes.

In this connection it is of interest that the reserves of the International Bank for Reconstruction and Development increased during the year ended 30 June 1959 by $70·5 million, that is by 17 per cent. Much of this addition was made up of an increase in net earnings but it hints at the beneficial effects of the increased international liquidity over the last year or so.

Shipping Survey Plans

Sir Nicholas Cayzer, president of the United Kingdom Chamber of Shipping, has announced that a survey is to be made of the world shipping industry, covering flags of convenience, possible cooperation between our dry cargo tramp owners and oil tanker owners and the scrapping of surplus tonnage. According to Sir Nicholas, there are at present 8 million tons of shipping laid up throughout the world for lack of freight.

Steel in South Italy

A new major steel plant is to be erected at Taranto in Southern Italy. It will be fully integrated with a capacity of 1 million tons of steel ingots a year and will cost about £90 million to build. Like the other three major steel plants in Italy, it will be built and operated by the state-controlled Finsider Steel Group.

This is one of Italy's most controversal industrial development schemes of recent years. In the opinion of experts, the choice of the site on the tip of Southern Italy has little to recommend it from an economic and technical point of view, since the steel is a long way from its nearest market which is northern Italy. The Bagnoli Plant which has been erected at Naples already more than meets the requirements of the South. The justification of this scheme is almost entirely social and represents a desperate effort to raise the industrial capacity of Southern Italy.

To some extent the views on this new steel plant are influenced by the severe setback in the Italian steel industry last year. Italy's steel output increased between 1952 and 1957 from 3½ million to 6·7 million tons a year. Contrary to the forecasts of the pessimists the establishment of the European Coal and Steel Community provided a major stimulus to the Italian steel industry, and the capacity was raised to over 8 million tons a year with the possibility of a further expansion of 2 million tons a year with only minor modifications to existing plant. During 1958 the industry operated well below capacity and is now faced with achieving a major recovery in the operation of existing capacity and absorbing an additional 1 million tons at Taranto in the next few years.

Applied Research for Europe

The committee for applied research of the European Productivity Agency has been considering the "rationalisation" of applied research work among members of the OEEC. The three major subjects considered have been fatigue failure in metals, study of prevention of fouling of ships' hulls, and how to obtain funds for research in member countries. On the first of these, cooperative research is to be stimulated; on the second organised trials are being carried out both in European waters and elsewhere and under the third heading the committee is making a survey.

Unification of the Clyde

Preliminary plans have now been approved to create the unified port authority responsible for all harbour and navigation facilities from Glasgow to below Greenock. This new organisation would absorb existing independent bodies and enable the Clyde Navigation Trust to expand its influence beyond the Port of Glasgow so that it could help to finance the proposed new graving dock at Greenock.

The graving dock is estimated to cost £4·25 million and the Government has indicated that it will loan about £3 million, provided that the balance can be raised locally. Raising £1·25 million on Clydeside will be made much easier if the Clyde Navigation Trust, which has large financial resources, becomes a participant in the scheme and the unification of the Clyde port and harbour authorities would bring this about. The Clyde Navigation Trust has agreed to help financially on certain conditions, which include firm guarantees from shipbuilding and ship-repairing concerns on the extent of their own commitment in the dock and the approval of the port unification scheme from the other main port authorities on the Clyde.

European Coal and Steel

ECSC steel production was up half a million tons in the second quarter of the year to 15·65 million tons. The biggest rise was in Germany where April-June production was 13½ per cent above 1958.

ECSC coal production in the second quarter was 2½ million tons down on last year. German production fell by 3·6 million tons and Belgian by 3 million tons. Pit-head stocks rose by 7 million tons in the first half of the year.

Aggressive Sales Policy for Coal

Addressing the Institute of Mining Engineers, Lord Mills, Minister of Power, referred to competition between coal and oil. He called for a more aggressive sales policy and referred, somewhat enigmatically to the fact that "the National Coal Board have been making throughout these difficult months a complete reappraisal of the industry's future."

Letters to the Editor

MODEL STRUCTURAL TESTING

SIR, Recent experience has shown that the testing of model structures for design purposes is a technique which is assuming considerable importance.

In view of the experience already gained in this field by the Structures Research Department of the Cement and Concrete Association, it has been decided that in future the Association will undertake model testing of concrete structures on a cost basis. Initially the amount of work undertaken will be limited by existing facilities. Work which could more appropriately be carried out in a commercial testing house will not be undertaken.

Inquiries in connection with this aspect of the Association's work should be addressed to Mr. A. W. Hill, B.Sc. (Eng.), M.I.C.E., Deputy Director of Research and Technical Services, at the address given below.

Yours faithfully,

P. J. WITT.

Cement and Concrete Association,
52 Grosvenor Gardens, London, SW1.
12 August, 1959.

Editor's Note.—Some notes dealing with the use of structural models in general and recent work by the Cement and Concrete Association in particular will be found on page 60.

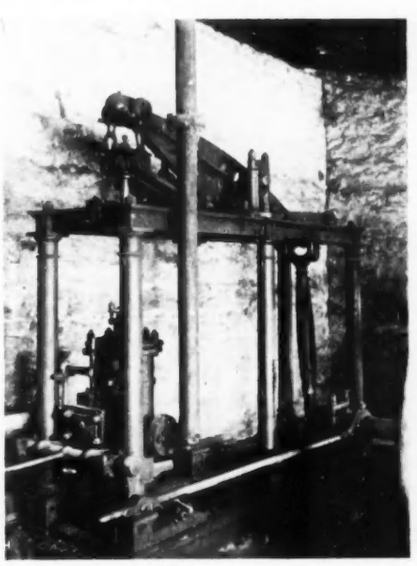
AN OLD BEAM ENGINE

SIR, Some few months ago you published an article entitled "Old Engines Come to Life" and illustrated a beam engine among others (ENGNG, 20 Mar. '59, p. 380).

The print of an engine, reproduced herewith, may be of some interest to your readers. It is of a beam engine which was used in a flour mill in Gawler, South Australia, and the photograph was taken in 1912. At that time I was acting as consulting engineer to the Gawler Town Council, in connection with the installation of an electricity supply undertaking to serve the area. Among the consumers being connected to the system was a flour mill which, at that time, was equipped with two beam engines.

The larger of these was used to drive the mill and the smaller (shown in the photograph) drove a d.c. dynamo for lighting purposes. If I remember rightly, the dynamo was of about 3 kW capacity and was driven from the engine by means of a spur gear and two countershafts in series in order to increase the revolutions per minute.

The set-up was rather Gilbertian. At the best, the light from carbon filament lamps was, to say the least, erratic, due to the cyclic irregu-



TAPPING AND REAMING

Bench Machine

THE Andytap is a bench mounted machine for tapping or reaming small components.

A high degree of accuracy is claimed for the machine which can be used for most materials and such components as pressings, stampings, brass and aluminium castings, mouldings and the many small machine parts.

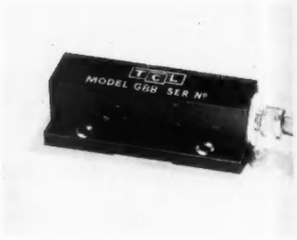
The machine is hand operated and can be set for right or left hand threads as required. Mounted on the head are two indicator lights that can be used to show the progress of the operation, one being a "caution" and the other a "stop" warning; they are particularly useful when tapping blind holes. They can also be used to indicate when the tap has reached a required depth. These lights are battery operated and can be used independently or, alternatively, a loose collar can be locked on the shaft for rotary work without using the lights.

The work table is mounted on two slide rods that allow adjustment for the size of component being tapped. The horizontal table can also be rotated. In addition there is a vertical faced table which can be used when the type of work requires it. The drive spindle and bearings are enclosed to give them some protection.

Threads up to 0 BA can be tapped in steel, or up to ¼ in Whitworth in non-ferrous materials. Reamers up to ¼ in diameter can be accommodated in the chuck. Equipment supplied with standard models includes an angle plate; tool post; a ¼ in chuck and the required operating keys for the chuck and the clamping locks. The whole construction is said to be robust to withstand normal workshop usage. *Monks and Crane Limited, Machine Tool Division, Garretts Green Lane, Birmingham 33.*

ACCELEROMETER

Measures Shock and Vibration



THE type G88 accelerometer weighs only 20 gm and has been introduced to meet the demand for a lightweight high sensitivity transducer capable of measuring shock and vibration on guided missiles, aircraft, packaging and also for general purpose use.

The piezo-electric ceramic material, known as TCL3 which is used in the accelerometer, has a wide temperature range covering from − 40° C to + 80° C. it also has a low temperature coefficient and possesses long term stability.

The accelerometer has a sensitivity of 80 mV/*g* with a capacitance of 1,000 pf. When used with a cathode follower of 100 megohms impedance, it is capable of measuring down to a few cycles per second.

Three feet of special low noise cable is supplied with the unit, connection being made by a subminiature plug and socket which isolates any cable whip from exciting the piezo-electric element. Owing to the high capacitance of the accelerometer, longer lengths of cable may be used without reducing the sensitivity to any great extent.

The transducer has a linear output over the acceleration range from 0·01 to 250 *g*. The transverse sensitivity is less than 5 per cent in any direction. Individual calibration is made over the range 20 to 800 c/s.

The body is fully sealed so that the accelerometer can be used in conditions of high humidity or of high dust concentration. The body itself measures approximately 1⅛ in long and is provided with holes for screwing in place. *Technical Ceramics Limited, Wood Burcote Way, Towcester, Northants.*

Continuing **Letters to the Editor**

larity of the engine. To make matters worse, the two engines were fed from the same steam pipe and the larger was adjacent to the boiler. The respective speeds of the two engines differed and at regular intervals each required steam at the same moment. Under such circumstances, there was none left for the small set and the lamps went "out" momentarily.

The mill was electrified and I endeavoured to purchase the small engine in order to present it to our museum but when the owners were informed of my intentions, they presented it to the Adelaide Museum, where it now lies.

When referring to old equipment, reference may be made to another flour mill which was erected on the banks of the River Yarra, at Dight's Falls, within the present Melbourne metropolitan area. In 1841, a licence was granted to the millers (for £100 per annum) to erect a race and water-wheel. Precisely 100 years later, in 1941, the Melbourne and Metropolitan Board of Works made use of the race when carrying out works in the area. The race was still in fair condition.

Yours faithfully,
GERALD B. LINCOLNE.

Melbourne, Australia.
30 July, 1959.

BUYING RUSSIAN

SIR, May I say a few words on the letters of Mr. W. M. B. Sarnecki and Commander J. H. Joughin in your issue of 7 August?

First, it is quite untrue to say that the USSR was ever an ally of Hitler. At the closest relations never got beyond a non-aggression pact, and Mr. Sarnecki has only to refresh his memory from Hitler's speech giving reasons for attacking Russia in 1941 to see that the USSR was very remote from playing the part of an ally, whatever certain of the Western press had been saying on the subject.

Secondly, I would like to have Commander Joughin's precise source for his "quotation" from the Finnish Communist Party in 1953, as I simply do not believe it. Ever since 1917 there has been a flourishing industry in the manufacture of "quotations" from alleged Soviet or Communist sources, simply aimed at bedevilling international relations. Commander Joughin's "quotation" bears the familiar trade mark of being too good for anti-Soviet propaganda to be true. If he will kindly state when and where the Finnish Communist Party ever made such a statement I shall be glad to investigate it. Until then, frankly, I believe it has been "manufactured abroad."

Finally, treating trade as trade, where do British interests lie? This country, above all, requires an expanding market for its products. The USSR, of all countries, has an expanding economy and an expanding foreign trade. It is prepared to offer Britain a continually expanding market for British goods, guaranteed against the shocks and crises to which Western markets are liable. Either we make the most of this market, or, very soon, our competitors in West Germany and the USA will be getting so well dug in that we won't have a chance to recover from our present reluctance.

Yours, etc., PAT SLOAN,
General Secretary.
British Soviet Friendship Society,
36 Spencer Street, London, EC1.
14 August, 1959.

NUCLEAR POWER SUPPLIES

SIR, I have read the editorial of your journal of 19 June in which some doubt is cast on the advisability of proceeding with a nuclear power generation programme in Europe. Your editorial reads to me exactly like the old story of the Trojan wooden horse. Surely the unpredictable nature of Europe's coal production, together with the supply of oil from the Middle East and our kindly business men in Texas, should not be allowed to affect the long-term plans for building up a source of electricity from nuclear power generation in Europe, including the British Isles?

Yours truly,
H. M. WILSON.

Lenzie, Glasgow.
10 August, 1959.

HUGHES BOLCKOW'S JUBILEE

SIR, I am preparing a short history of the Hughes Bolckow Shipbreaking Company of Blyth, Northumberland, which celebrates its fiftieth anniversary in 1961. If any of your readers could provide information about the company's early activities I should be deeply indebted. Any photographs or documents would be carefully looked after.

Yours sincerely, HORACE WHITE,
Group Public Relations Officer.
Metal Industries Limited,
Brook House, Park Lane, London, W1.
12 August, 1959.

CURRENT SOURCE

A PROGRAMMABLE constant current source of very high accuracy has been introduced by the North Hills Electric Company, Incorporated, to give currents from 1 microamp. to 100 milliamps in steps of 1 microamp, and at load voltages from zero to 50 V. Current is set by five decade knobs with an accuracy of within 0·02 per cent and short term stability of 0·001 per cent. *Ad. Auriema Incorporated, 85 Broad Street, New York 4, NY, USA.*

COOLANT PUMP

DESIGNED for the machine tool industry a new SEM coolant pump has an output of 2 to 3 g.p.m. at a head of 6 ft. It is of the submersible type with a balanced impeller and the motor is totally enclosed. Mounting is by flange or clamp and the overall length of the unit is 13¼ in. *SEM Limited, Eagle Works, Churchfields Road, Beckenham, Kent.*

TRACTOR LOADER

THE Mastiff Tractor loader is a four wheel drive machine and is claimed to be the first all-British machine of this type. It is driven by a 96 h.p. engine and has a 1½ cu. yard bucket, four wheel drive and four wheel steering. Other features are a torque convertor transmission with power gear shift, power assistance for the steering and equal sized wheels of 14 in by 24 in. *Mathew Brothers, Matbro Works, Sandy Lane North, Wallington, Surrey.*

DIGITAL DISPLAY

SERIES 100 digital display units are ⅜ in high and give one plane presentation. They embody the same features as the earlier series which was 1 in high, and operate on 12 light channels so allowing for the figures 0 to 9 with a decimal point and a coloured background. Alternatively, the letters of the alphabet can be displayed on two units. The units can be assembled in any desired grouping and it is claimed that the flat presentation allows the figures to be read from any angle. *Counting Instruments Limited, 5 Elstree Way, Boreham Wood, Herts.*

MINING MACHINERY EXHIBITION

Held at Olympia 9-18 July

In the ten year interval that elapsed between the recent exhibition of mining machinery and its predecessor, a major change of emphasis has occurred. In 1949 the theme was coal—as much and as quickly as possible; now in 1959 the song is coal—as cheaply as possible, for only by keeping down costs can coal maintain its position in competition with oil, gas, and even nuclear energy. These points were brought out by Lord Mills at the opening and again by some of the other speakers. The exhibition was organised by the Council of Underground Machinery Manufacturers.

The change in emphasis has led to a change in the position of mining machinery manufacturers in this country. Whereas in 1949 virtually all machinery was bespoke for home consumption, now they have capacity to enter the export market—and indeed must do so to maintain their position. The exhibition, which was held at Olympia, London, was therefore timely and the 24,000 visitors (2,400 from overseas) were very welcome. The attendance was approximately two and one half times that of the 1949 exhibition.

Although the emphasis is now on cost, the demand for machinery will still exist for it is by the installation of more and better machines that the greater output per unit of cost can be achieved. But to attain this the machines themselves must be more efficient and must produce the right sizes of coal wherever possible. There are therefore more automatic and semi automatic rigs. With the demand for higher powers comes also the problem for the designers of size, for the seams do not get any larger and to fit motors (and flame proof models of necessity) of 60 or 70 h.p. into seams that may be only 18 in high, offers an exercise in compactness and cooling. In this connection is is interesting to note that probably the majority of the electrical equipment used underground is made by the machinery manufacturers themselves.

Another of the major changes is the extending use of hydraulics. The wooden pit prop is almost a thing of the past now, and its place has been taken by steel beams. At the coal face however the roof is frequently supported by hydraulic props which are adjustable and will move forward under power as the cutter gets the coal. Hydraulic power is also used in drills, picks and traversers though ultimately it must derive its origin from a prime mover, usually through an electric motor. The conveyor belt has come into such use that the cost of replacements has become the largest single item in the Coal Board maintenance accounts. Although mainly for coal the machinery exhibited also covered all other forms of mining.

COAL CUTTER
Electrohydraulic Operation

THE Siskol electrohydraulic coal cutter is a new design of radial percussive machine for use in narrow places, and has the advantage of being entirely power driven.

Power is supplied by a 5 h.p. flameproof electric motor, on the rear of which is mounted the hydraulic pump that supplies oil for the traverse movement. The five-prong cutting tool strikes the coal face with a combined rotary and percussive action at the rate of 400 blows per minute. At the same time the cutting tool is swung in an arc across the coal face. This operation in former models was doen by hand. The actuator gives a swing of 180° and is under the control of a three-way valve allowing the swing to take place in either direction as desired.

Other new incorporated features include a rotary pilot and isolating switch mounted on the terminal box of the motor, which is designed for use with a standard gate-end panel. Over the rotating chuck a wire mesh guard has been fitted and has been made to slide back over the gearbox of the machine so that extension rods can be changed. Also, a new arrangement for dust suppression is used in which the water supply is fed through the chuck, along the hollow extension rods and is discharged in a cone of spray round the cutting head. It is possible to use flexible rotary drills on the machine by removing the hydraulic pump from the rear of the motor and connecting the shafting in its place. Although the model illustrated is on a skid mount, it is more usual to be mounted on wheels. *Siskol Machines Limited, Penistone Road, Sheffield 6.*

COAL WINNER
For Producing Large Coal

THE Coal Winner is essentially a conversion unit for Anderton Shearer machines with the intention of producing as cheaply as possible a high percentage of large coal.

The action is to cut at both the top and bottom of the seam with rotating drums of comparatively small diameter, and at the same time to shear at the back of the cut with a narrow kerf jib. Thus the main section of the seam is left almost unbroken and the only fines produced are from the actual area of passage of the picks.

With this machine the maximum height of seam that can be cut in a single pass is 53 in and the maximum unbroken block is 2 ft less than this. The coal is delivered at the rear of the machine on to a loading plough and thence to an armoured scraper conveyor on which the complete machine is mounted, and on which it traverses the face. A wedging platform breaks down extra large pieces of coal to manageable sizes.

The standard head is mounted on the machine in the place of the normal Anderton drum. It can be rotated about its mounting to cut any seam width between 32 in and 53 in, without other adjustment except that the machine must be raised or lowered on the conveyor so that the lower cutter is always on the floor of the seam.

The head consists of a gearbox bolted to the cutting unit of the machine and having at each end a rotatable drum carrying cutter picks. These drums are connected at the face side by a shearing jib and chain of conventional design. *N. J. Muschamp and Company Limited, Station Street, Mansfield Woodhouse, Nottinghamshire.*

STRAPPING

THE Band-It strapping system uses stainless steel strip to tie bundles of rods or bars together or to couple hoses to pipes.

A small hand machine applies the strapping and makes the seal. Very high tensions can be obtained in the strap, approaching the strength of the steel itself. One of the great advantages of the system over the use of fabricated hose clamps is that there is no wrong size; any hose can be clamped using the tool and a coil of strip. This saves having to carry a large number of couplings around and the nuisance of not having the right size available when some distance from the source of supply is avoided.

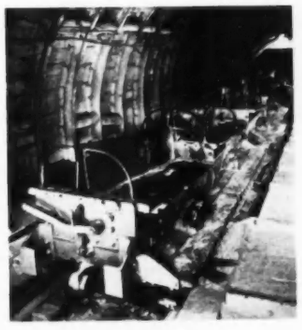
The same tool and strip can be used to attach neoprene sleeves to ducting; wooden stilts to the bottoms of colliery arches; or for suspending pipes from brackets. *G. E. Simm Engineering Limited, 27 Bromgrove Road, Sheffield 10.*

PROXIMITY SWITCH

ORIGINALLY designed for levelling mine car hoists, these proximity switches are magnetic in action and require no physical contact between the two parts.

A permanent magnet is fixed on the moving cage, and the switch itself on the side of the shaft. As the magnet passes the switch the internal element of the latter is operated by the field, either opening, closing or reversing the contacts according to the type of switch and the purpose for which it is being used. Switches can also be resetting or "stay put": in the latter case the armature remains in the position as after the last operation by the moving magnet and only turns back when the magnet again passes it in the opposite direction. Satisfactory operation has been obtained with these switches at passing speeds up to 65 ft per sec. *Metropolitan-Vickers Electrical Company Limited, Trafford Park, Manchester 17.*

SAFETY BRAKE
For Use on Man-Riding Carriages



CARRIAGES carrying men down steep slopes have to be fitted with automatic safety brakes that operate in the event of a runaway or a rope failure.

The version designed by the AEI group acts directly on the track and is claimed to give protection on steep gradients or when the track is dirty or fouled by sludge.

The mechanism is such that in the event of rope failure a toggle link is reversed which removes the support from the running axles of the car allowing the whole weight to be taken by the brake shoes on the track. The wheels maintain contact with the rails so that the flanges still hold the car in position. The brakes can also be applied by the gang rider using the trip lever on the leading car. The control mechanism is linked to all cars in the train.

Each carriage has four independent brake shoes which are spring mounted to give full braking even when there are inequalities in the track. Spherical seatings make the shoes self aligning and the shoe edges are chamfered to ride over bad rail joints. On test a train running on rails smothered in anthracite sludge on a sine gradient of 1 in 2·2 was pulled up in a distance of 18 in. At 6 m.p.h. on a gradient of 1 in 2·5 a train can be stopped in 20 ft. On lesser gradients stopping can be achieved in a reasonable distance even when the train may be travelling at a speed of 24 m.p.h. or above. *Associated Electrical Industries Limited, 33 Grosvenor Place, London, SW1.*

BRIDGE CONVEYOR

Flexible Loader Link

A BRIDGE conveyor has been designed as a link between a Samson loader and the main gate conveyor so that the loader can move freely across the working face and the gatherings are continuously delivered to the main collection point.

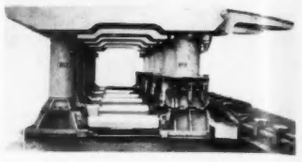
The loader has a short jib which can be raised or lowered hydraulically but does not need to be slewed and therefore can be made rigid sideways. Underneath it is an arm carrying the ball of a ball and socket joint by means of which one end of bridge conveyor can be picked up and held clear of the ground. It thus makes a flexible connection between loader and conveyer, allowing the former freedom to move across the work face and within a limited distance, backwards and forwards.

The structure of the conveyor is a lattice framework supporting a troughed belt conveyor, the belt of which can run at speeds of 250 ft per minute. Power is supplied by a 5 h.p. hydraulic motor driving through reduction gearing to the head pulley. The hydraulic supply pipes run to the tail end where there is a quick make and break self-sealing connection to a pump on the loader driven by the loader motor.

When installed under ground, the out-bye end of the bridge conveyor is either hung by a pivot from a wheeled block running along an overhead girder, or it may be supported on a carriage astride the gate conveyor. At both ends plates guide the material and the joint allows a relative movement of up to a right angle to each side. The bridge conveyor follows the movements of the loader, both endways and sideways, allowing the face of the tunnel or heading to be cleaned up without loss of time. The example shown was 35 ft long and was connected to a Samson type MC3 loader. *Mavor and Coulson Limited, Farme Cross, Rutherglen, Glasgow.*

SELF ADVANCING CHOCKS

Hydraulic Operation



THE self-advancing chock offers several advantages in labour saving and for semi-automatic operation of mining machinery. By suitable interconnection of the control mechanism the chocks can be made to follow the cut of the machine and move forward in sequence as the cuts are made. They can also be used for advancing the conveyer.

New versions of Desford chocks are gull wing and goalpost types. The first consists of two 50 ton Desford chocks and a double acting ram which operates between them.

The ram is then used to advance each chock in turn so that the roof remains fully supported at all times. Each chock carries a double section roof bar, and additional support is given by the gull wing roof bars that are operated by the hydraulic system mounted on the front chock.

The second, the goalpost type, consists of two 50 ton Desford chocks acting as a single unit and carrying a common roof bar capable of withstanding a load of 100 tons at any point. An hydraulically operated and articulated extension reaches out over the conveyor. This is the type illustrated. The unit has an area of contact with the roof of 10 square feet.

Static Desford chocks can be fitted with push-pull rams for moving over the conveyor and for advancing themselves under power. All equipment is water operated, the supply being drawn either from a high pressure fire main (open circuit) or from an in-bye motor driven high pressure pump (closed circuit). All chocks can be set at the same pressure, regardless of the human element, which reduces bed separation to a minimum. High initial load setting is a special feature claimed for these chocks. *A. G. Wild and Company Limited, Charlotte Road, Sheffield 2.*

CAR TIPPING

IN the Vial system of mine car tipping the operation takes place while the car is still in the hoist.

As each mine car is hoisted to the surface it remains in the cage while the contents are dumped. The operation is therefore similar to using a skip hoist with side discharge into a bin and offers the same speed of turnround. The system is especially suitable for those mines which have a comparatively small daily tonnage output and also for those where the density of the deposit is low resulting in the construction of relatively temporary hoisting and surface arrangements. With the Vial system no complicated arrangement of tracks is needed at the surface, but the same simplicity as with decked mine cars is maintained underground. Nor are surface tipplers or sheltering buildings required. Hoisting from several levels is also made easy. *W. G. Allen and Sons (Tipton) Limited, P.O. Box No. 4, Princes End, Tipton, Staffordshire.*

CONVEYOR DRIVE

THE "Two Hundred" driving head is designed for heavy duty, great length or steep gradient conveyors demanding high horse-power. It also enables advantage to be taken of the increased length made possible by the use of synthetic fibre belting.

The head has a capacity of from 200 to 325 h.p. at speeds from 350 to 600 ft per minute. There are two 42 in driving drums of heavy rolled steel construction mounted on self-aligning roller bearings fixed in renewable housings located along the horizontal joint of the split gearbox. As all other reduction gear bearings are similarly mounted in the same plane the whole of the gearbox assembly is available for maintenance and inspection without disturbance of any working parts, simply by removing the top half of the gearbox. Normal splash lubrication within the box is supplemented by a mechanical oil pump. *Richard Sutcliffe Limited, Horbury, Wakefield.*

PLUMMER BLOCKS

THE Fenner-Dodge type SC plummer blocks are for ball bearings with a range of shaft sizes from $\frac{3}{4}$ in to $2\frac{1}{2}$ in.

Particular claims are that these are sealed bearings with relubrication facilities; that the housing is easy to fit as there is adequate spanner room and the bolt holes are elongated to allow for adjustment; that a separate collar provides bearing to shaft fixing without distortion of the inner race; that the seal has low friction losses and keeps grease in and dirt out; and that the deep groove ball bearing with a long inner race distributes loads over greater shaft area and is fully self aligning. They are supplied in non-expansion types only.

The outer race is prevented from turning by a locking pin which also serves to locate the lubrication hole. The seals cannot be blown out when a grease run is used. As well as plummer blocks the series is available in two and four bolt flange bearings. *J. H. Fenner and Company Limited, Hull.*

TRAIN SIGNALLING

A signalling system developed for controlling underground haulage systems allows both automatic and manual control of train movements. All components are flameproof.

Three-colour lamps are used at protected sections of the track with red for stop; red and amber for stop, wait your turn; and green for proceed. Right of way for the locomotives is given in sequence, notification being made by trackside switches operated by the locomotives themselves. There are two sets of track switches, one marking the arrival of the train in the protected section and the other its departure from the section.

The control, cancel, and guard relay groups are mounted in one cabinet, and groups are linked together to safeguard the protected section. A common cancel group interlocks the lamp switching relays so that conflicting signals cannot be given. *A. T. and E. (Wigan) Limited, Pioneer Works, Wigan.*

EXTENDING CONVEYOR

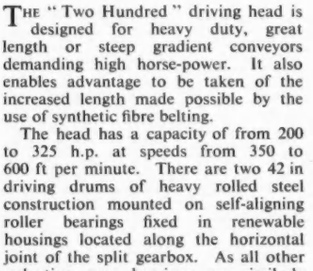
Self Powered

THE Distington-Goodman Ropex high capacity belt conveyor has been designed to extend or contract under its own power.

The equipment consists of a drive section, take-up framing, intermediate section, and tail section. A belt spooling device can be installed directly in-bye of the take-up section for easy handling of additional sections of belting when greater extensions are required.

The Ropex conveyor has been designed to extend 50 to 100 ft without the addition of belting, depending on the number of take-up sections used. Automatic light signalling provides an indication of the need for belt addition before the limit of stored belt is reached. All operations of the unit, except the belt drive, are performed hydraulically by means of crawler hydraulic motors which are attached to the head and tail ends of the conveyor and which are interchangeable.

The belt drive is powered by a 35 h.p. electric motor and has a forward speed

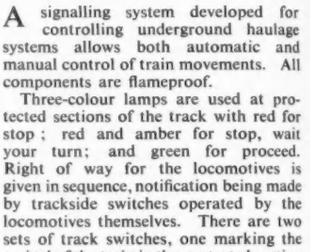


of 400 ft per minute and a reverse speed of 200 ft per minute. The belt spooling device has a capacity of 100 ft of belting so that one spool is required for every 50 ft of advance. Additional reels carry 100 ft lengths of belt which can be inserted by breaking the main belt at a coupling point and joining in the new length.

The reels are mounted on tracks so that they can be slid into position without difficulty. The added section would then be accommodated by the take-up unit and would allow the main conveyor to be extended for another 50 ft. *The United Steel Companies Limited, 17 Westbourne Road, Sheffield 10.*

DOUBLE TURRET JIB

Parallel Cutting in Thin Seams



A CUTTING jib with two vertical turrets is claimed to have been operated successfully in a seam only 2 ft 3 in thick.

The machine consists of an orthodox flat jib with a parallel jib placed over approximately half its length from the toe end, and on the parallel jib two vertical turrets. The machine can be made with jib lengths to suit individual requirements and the height of the turrets can be chosen to accord with the height of the particular seam.

Particular advantages claimed for the double turret jib as against the conventional flat jib and the triangular turret type are that no shots are required, leading to a consequent saving in manpower; that coals are adequately prepared for the fillers, which are then hand filled on the usual way; that the machine produces a high percentage of over 6 in coals with a corresponding reduction in the amount of smaller sizes; and that roof conditions have shown an improvement when it has been used. It is also claimed that with regular maintenance breakdowns are rare and renewals infrequent. Cutting speeds are between 2 and 4 ft per minute and it is said that the double turret jib is easier to control and will remain in its proper cutting plane without difficulty and without any tendency to climb up the seam.

During trials in a 2 ft 3 in seam with a hard stone clunch floor and a dark soft bind roof, the double turret machine gave an increase in output of 16 cwt per man shift with 60 per cent of the coals cut above 2 in. At the same time five less men were needed. *Edibrac Limited, Centurion Works, Hartington Road, Broadheath, Manchester.*

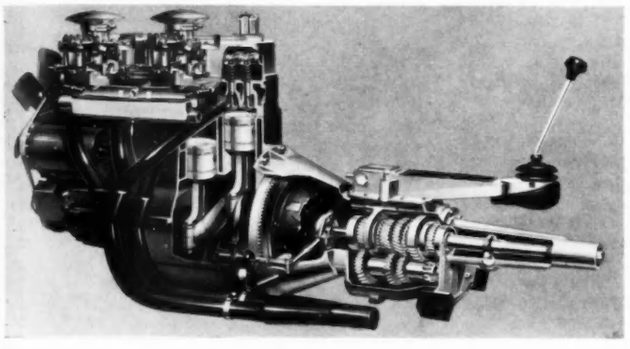
THE SUNBEAM ALPINE

Two Seater Sports Car

By Gordon Wilkins

Rootes are entering the two-seater sports car market with a popular priced roadster which has smooth style, unusual weather protection and disc brakes. Mechanical parts are based on those of the Sunbeam Rapier, but the engine is extensively modified to raise the power output to 83·5 b.h.p. (SAE) and 78 b.h.p. (installed), and the car has an entirely new all-steel unit structure. Basic model is a two-seater roadster with wrap-round windscreen and wind-up glass side windows, but a detachable hard top is available. There is a small luggage trunk and additional space for baggage behind the seats on a platform which can also be used as seating space for two children.

Power of the four-cylinder o.h.v. pushrod engine (1,494 c.c.) has been raised nearly 10 per cent, chiefly by the use of a new aluminium cylinder head with inclined valves in line and a compression ratio of 9·2 to 1. There are four inlet and four exhaust ports and valves are arranged alternately, inlet, exhaust, inlet, exhaust, right down the head to simplify cooling and reduce head distortion under heavy duty. The crankshaft runs in three white metal bearings and there is a new camshaft, also in three bearings. Big end bearings are copper-lead, indium lined. To strengthen the block, stiffening webs now run down inside the crankcase wall. The crankshaft is of steel with higher tensile strength than that used for the Rapier. Carburettors are two downdraught Zeniths and there is a four-branch exhaust system merging into twin down-pipes.



(Above) A 1½ litre car with smooth style and unusual weather protection.

(Left) The Alpine engine has a power output of 83·5 b.h.p. (SAE) and a compression ratio of 9·2 to 1.

Transmission is through a single-plate Borg and Beck clutch of 8 in diameter with hydraulic control, four-speed gearbox with synchromesh on top three, controlled by a central lever, and hypoid rear axle. In the gearbox, top, third and second gears are more closely grouped than on the Rapier, which is a welcome improvement, but bottom gear is lower than ever so that the gap between first and second is wider.

Alpine gearbox: 3·346, 2·141, 1·392, 1 to 1. Reverse 4·239 to 1. Rapier gearbox: 3·187, 2·471, 1·491, 1 to 1. Reverse 4·037 to 1.

Laycock de Normanville overdrive is available, functioning on third and top speeds. Normal axle ratio is 3·89 to 1 but when overdrive is fitted a 4·22 to 1 axle is used.

Front and rear suspension are conventional. Girling disc brakes of 9½ in diameter are used at front, with pads giving 20·6 sq. in of friction area. Drum brakes are used at rear with 9 in drums and 60 sq. in of lining area. Wheels are perforated bolt-on discs, but centre-lock wire wheels are an optional extra. Tyres are 5·60—13. Steering is Burman recirculating ball.

An interesting detail is a hollow central armrest with a lockable lid forming a locker for gloves, sun glasses or a camera.

Body-chassis structure is an all steel unit with centre cross bracing, built by Armstrong Siddeley using pressings supplied by Pressed Steel. They assemble the car, with mechanical elements supplied by Rootes, who retain control of all marketing and service matters. Styling was done in Rootes' own design department.

The car has a wheelbase of 86 in and dry weight of 2,082 lb. Maximum speed is said to be 98 to 100 m.p.h.

TWO NEW MODELS FROM GERMANY

LLOYD 900 SEDAN

Flat-Four Engine and Front Wheel Drive

Lloyd steps out of the minicar class and into the small family car class with the new Lloyd 900, a two-door four-seater sedan which is competitive with Volkswagen, Dauphine, Morris Minor, Goggomobil T 700 and the new DKW Junior.

The unit construction sedan body is built round a central tube backbone following usual Lloyd practice but the flat four engine represents a new development for them; it is water cooled, not air cooled. Nor is it a development of the engine used by the associated Goliath concern. It is a new unit made basically of two iron castings, each forming two cylinders and half of the crankcase. The crankshaft has three bearings and the valves are operated by pushrods from a central camshaft. The claimed output of 30 b.h.p. from 897 c.c. is one of the highest outputs for size in the small car field. Transmission is via a four-speed gearbox with synchromesh on all four speeds. The makers claim the car will accelerate from 0 to 50 m.p.h. in 16 sec., 0 to 60 in 26·5 and reach a maximum of 75 m.p.h.

Springing is of conservative design; twin wishbones with a coil spring and telescopic damper above the top one at the front; trailing arms, coil springs and anti-roll bar at the rear. The hydraulic brakes have a total lining area of 105 sq. in.

Instruments are combined in one dial under a cowl in front of the driver. The steering wheel has two spokes and a recessed centre. Front seat backrests fold forward for access to rear seats but a safety catch prevents them being pushed forward in an accident. The rear seat folds to make a big cargo space extending back into the trunk. Equipment includes windshield washer, parking lamps, reversing lamp, cigarette lighter, warning lamp for fuel reserve, and an indicator to show if a tail lamp goes out. The trunk is lit by the licence plate lamp and the spare wheel lies in a cradle underneath. Estimated price when production begins, £450.

Technical Details

Engine: Flat four, water cooled, 69 by 60 mm., 897 c.c. Compression 7·5 to 1, 38 b.h.p. at 4,800 r.p.m. Max. torque 44·75 lb-ft at 2,500 r.p.m. Transmission: Front wheel drive. Single plate dry clutch (automatic clutch optional). Four-speed all synchromesh gearbox. Gearbox ratios 4·77, 2·53, 1·57, 1·09 to 1. Reverse, 4·54 to 1. Axle ratio, 3·87 to 1. Dimensions: Wheelbase 86·6 in, track (front and rear) 47·25 in, length 149·6 in, width 59·4 in, height 54·9 in, tyres 5·20-13, kerb weight 1,530 lb.

BMW 700

Small Sports Coupe with Flat Twin Air-Cooled Rear Engine

With the announcement of the BMW 700, the BMW company seem to be turning from miniature economy cars for the mass market to a small quality car with sporting performance. They tried at first to put a coupe body on the same tubular chassis as the front-entrance four-seater 600 but have finally evolved a new all-steel unit-construction job. Rear engine, transmission and suspension group is developed from the 600 but with many improvements. New cylinders with larger cooling fins raise the bore to 78 mm and a new crankshaft raises the stroke to 73 mm giving 696 c.c. instead of 582. It has a vibration damper, bigger carburettor, and thermostatic control for the air cooling. Front suspension is by parallel arms, coil springs and telescopic dampers as on the 600. Steering is by rack and pinion and brakes are larger to give 90·5 sq. in lining area. Transmission ratios are unchanged but the road speed for given engine r.p.m. is higher as wheel diameter is increased to 12 in, still with 5·20 tyres. There are two separate front seats and two small seats for children. The fuel tank is in front under the floor of the luggage trunk and the spare wheel stands vertical in the extreme front. Michelotti did the styling. Works figures give acceleration from 0-50 m.p.h. in 16 sec, 0-60 in 25·5 sec and maximum speed as 75-78 m.p.h. Basic price will be about £450.

Technical Details

Engine: Flat twin air-cooled at rear. 78 by 73 mm, 696 c.c., ohv pushrod operated. Compression ratio 7·5 to 1, 30 b.h.p. installed at 5,000 r.p.m., 35 b.h.p. SAE at 5,200 r.p.m. Max. torque 37·1 lb-ft at 3,200 r.p.m.

Transmission: Single plate dry clutch. Four-speed all-synchromesh gearbox with central lever. Gearbox ratios, 3·54, 1·94, 1·27, 0·846 to 1. Reverse 3·45 to 1. Final drive 5·43 to 1. Dimensions: Wheelbase 83·4 in, track (front) 50 in, (rear) 47·25 in; length 139·4 in, width 58·27 in, height 49·6 in, tyres 5·20-12, kerb weight 1,385 lb.

Electricity and Politics

The review of activities for the year ended 31 March 1959 by the chairman of the General Electric Company, Sir Leslie Gamage, suggests a fine balance of favourable and unfavourable factors likely to affect the electrical engineering industry during the remainder of this year and next. The commercial position is good and very much better than it was a year ago. GEC's order book stood at £133 million at 31 March, while turnover for the year was £108 million. The improvement in demand, which began to be felt last January, has continued and it is in the sphere of politics that Sir Leslie sees "some clouds in what would otherwise be a clear sky."

The liberalisation of dollar imports, the recurring demands of labour and the general election in the offing are the main factors which create uncertainty. Sir Leslie is cautious in his approval of British moves towards a free trading area for the "Outer Seven." "I doubt," he said, "whether this by itself holds any dramatic advantages for industry as a whole, but I endorse the proposal hoping that it will provide a bridge for closer association with the Common Market. For the British electrical industry, liberalisation of trade between the Outer Seven should on balance, bring some advantages, but business may be hindered for a time by the differences between British and Continental standards."

Considering the development of nuclear power, Sir Leslie pointed out that in GEC's view "there is only a limited market for the present form of gas-cooled graphite-moderated reactor overseas owing to its high capital cost." He urged an intensive new approach to reactor dimensions and electrical capacity to reduce capital costs, and told shareholders that GEC has gone some way in that direction and submitted to the Admiralty a design covering a reactor for marine propulsion. GEC's profits for the year were slightly up on 1957-58 at £9·41 million. The reorganisation of the group into products divisions, as has become the fashion among the larger electrical engineering companies, has continued during the year.

Major Contract for Rustyfa

The British consortium of five engineering companies Rustyfa Limited (the name being derived from Russia Tyre Factory, representing the company's first large order, which led to their formation) have signed a contract with Masinimport of Bucharest for the design and supply of a tyre factory capable of producing 1 million car tyres, 500,000 motor cycle tyres and 1½ million bicycle tyres per year. Dunlop Advisory Service are acting as consultants to the project which involves a total expenditure in the UK in excess of £7½ million.

Hawker Siddeley Remoulded

The development of the Hawker Siddeley group has been rapid in recent months. Despite bitter disappointments in Canada they have gone forward with their reorganisation and achieved what appears to be a much greater degree of homogeneity and compactness. A major step, taken last June, was the establishment of a central advanced project unit to guide the development of the group's aviation activities. Mr. James Floyd has been recalled from Canada to take charge and is setting up his new organisation in Kingston. Making the announcement, Sir Roy Dobson, the group's managing director, explained that Mr. Floyd would be directly responsible to the technical director of Hawker Siddeley Aviation Limited, Mr. Stuart Davies, and would be able to draw "on all the research, design and development facilities within the group," and that his team's work will have "top priority in the group's future activities." Mr. Floyd, a vice-president for engineering of Avro Aircraft Limited in Canada, was educated at the Manchester College of Technology, and worked with A. V. Roe, Manchester until he went to Canada as Avro's chief project engineer.

Other moves by the Hawker Siddeley group include the formation of a new company, Hawker Siddeley Brush Turbines Limited, as a subsidiary of Hawker Siddeley Industries. The new company, in which will be concentrated all the group's efforts in the field of industrial turbines, will be based in part of the existing works of Gloucester Aircraft Company at Hucclecote. Its range of products will include industrial steam turbines previously manufactured by Brush Electrical Engineering Company, Loughborough; free piston gasifyer applications in the turbine field; turbochargers for diesel engine applications; industrial type combustion turbines, including turbines manufactured under licence with Clark Brothers, New York. The managing director of the company will be Mr. G. B. R. Feilden, who achieved the reputation of being Britain's foremost industrial turbine engineer whilst in control of Ruston and Hornsby's gas turbine activities. A fellow of the Royal Society, Mr. Feilden was responsible for the installation of the first Whittle jet engine in the Gloster E.28/39 Britain's first jet aircraft.

It was announced last week that Hawkers have made an offer to purchase all the ordinary shares of Folland Aircraft Limited; the board of Folland's recommend that the offer be accepted.

Diesel Locomotive Switch

The Italian Sta Finanziaria Meccanica announced recently that it had secured a contract for the supply of 280 diesel electric locomotives to Argentina. While the first 80 locomotives are to be built entirely in Italy, Argentine industry will participate in the construction of the others. This will be made possible by the construction of two new factories, which, with the existing Fiat engine works at Cordoba, will be capable of building 80 per cent of each locomotive in Argentina.

In recent years, Argentina has not been such an important market for British locomotives as was formerly the case. Even so, the development of a local locomotive building industry will not be without effect on British export prospects. Early this year, for example, Robert Stephenson and Hawthorns shipped the first of 21 diesel-electric locomotives ordered by the Argentine State Railways. These 72 ton 1,000 h.p. locomotives were due to be despatched at the rate of two a month and were the first diesel-electrics to be exported to Argentine by this company. They might have been expected to lead to further orders but the Italian contract would seem to preclude the development of further large-scale exports from this country.

In the last three years there has been a marked fall in total British exports of diesel and diesel-electric locomotives from £10·1 million in 1956 to £4·6 million in 1957 and £2·8 million in 1958. In January and February of this year, the Transport Commission placed large orders, partly because of the spare capacity which was developing in the industry. As a result of these and other orders placed in connection with the railway modernisation programme, most locomotive builders will have a considerable volume of work in hand for the next two or three years. Once the peak demand under the modernisation programme has passed, however, a revival of export demand will become essential if existing capacity is to be reasonably fully employed.

Rolls-Royce Optimistic

Lord Kindersley, chairman of Rolls-Royce, expects performance in 1959 to compare favourably with the £96 million turnover and £4·6 million trading profit of last year. He regards expenditure on research and development as "the key to the future." Since 1954 they have spent £8 million on capital equipment entirely associated with development, and in the last two years spent £10 million on the development of engines, most of it on engines not yet contributing to profits. This was equal to the company's total retained profits.

Laing on Cost Reduction

Laing's chairman, Mr. W. Kirby Laing, in his annual general statement published in June, spoke of intense competition in the construction industry and of methods used successfully by his company to reduce costs and to cut time schedules on contracts. An important point made by Mr. Laing was that the main scope for increased efficiency existed in the design and planning of a scheme which in too many cases were brought to the contractor already finalised. To be effective contracting firms should be brought in right at the inception of a construction scheme.

Bearings Run Smoothly

Bearing manufacturers have made a good recovery during the second half of last year and the industry is being kept very busy by the high level of activity in the motor industry and light engineering. There has also been an increase in the amount of direct exports in the case of several companies. The Glacier Metal Company were hard hit by the recession in the first half of their financial year (ended at 28 February) but shared in the subsequent upsurge in business. Net profit before tax was £212,464, compared to £229,018 the previous year and £492,176 during the peak year 1951-52.

The directors of the company took the view that prospects were good, particularly in view of the strong demand for the company's new products—reticular aluminium-tin bearings, dry bearings and centrifugal oil cleaners, all of which are the outcome of Glacier's own development and research. The net assets of the company, which in 1939 stood at £290,000, are now £2·8 million. Their chairman and managing director, Mr. Wilfred Brown, relinquished the managing directorship in order to devote more time as chairman "to a continuous study of the company, their markets and the industrial environment in which they operate." Their new factory extension of 30,000 sq. ft at Kilmarnock is almost complete and a further 25,000 sq. ft extension is being considered.

The chairman of the Hoffman Manufacturing Company spoke to his shareholders of an "ever-growing demand for high class bearings." They also have recovered well from the 1958 recession and look to the future for the demand for their products with confidence. British Timken Limited increased their consolidated net profit from £872,681 in 1957 to £1·06 million in 1958 and are said to be doing even better this year. They recently received an offer from the American Timken Roller Bearing Company for the 47 per cent of their share capital which the latter do not already own (the offer was rejected by the British shareholders). The Skefko Ball Bearing Company also improved their profits during 1958 but found that business declined towards the end of the year. Their chairman, Sir Victor A. L. Mallet, commented that this reduced level of activity was continuing into 1959. He noted, however, welcome indications of a trade revival and told shareholders that the company were continuing their expansion and modernisation programme on which they will have spent £3 million in four years. Pollard Ball and Roller Bearing Company did very much better than most: profits increased from £250,000 in 1957 to £371,000 last year and the volume of sales has continued to expand. They also are expanding capacity.

Who Goes Home?

The leisure time of wage earners is increasing fast, but for managers the reverse is probably the case. An American commentator recently described the distribution of leisure as "tending towards an inverted pyramid . . . with work for the classes and leisure for the masses." An article published in the February issue of AFL-CIO *American Federationist* attempts to refute this theory and generally to discredit the contention that "the professionals, the executives, the educators, the people who run organisations of one kind or another, are at the moment those who have the least surplus time and who will be the last to receive it."

The AFL-CIO article points out that the 40-hour week has by no means extended to all workers (but does not dispute the inevitability of the trend towards shorter working hours for wage earners) and also that many industrial workers are on shift work. The comparatively low incomes of wage earners, it states, prevents them from enjoying their leisure. The executive who comes home late with work in his brief case has a better chance of utilising what leisure he gets to his personal profit. Nothing is put forward which seriously challenges the assertion that leisure, in the form of short working hours, is mainly for hourly-paid workers.

There are signs, however, that this state of affairs may change eventually, if only because the executive population is increasing fast both absolutely and in relation to the wage earning population. An article by Mr. Curtis G. Benjamin, president of the American Book Publishers Council, and the McGraw-Hill Publishing Company, released by the National Office Management Association under the title "Office Executive," discusses the problems that this growth has created. According to Mr. Benjamin, "the tidal wave in office employment rolls on—ten years from now it is expected that of every 100 workers in America, 21 will be employed in offices." Many additional managers will be required, whose title may be "office managers" but who will in fact be managers in all areas of business. The office manager has traditionally little leisure, but in the future he will have to function as a personnel specialist, a cost accountant, an authority on communications, a methods analyst and an expert on the practice of business data processing. His hope, and that of managers everywhere, is that the understanding of management will advance in step with the growth in the management function and that a more orderly, more leisurely life will result.

Operational Research Course

The department of engineering production at Birmingham University has issued its syllabus for the post-graduate course of studies for its M.Sc. course in operational research. This course was offered for the first time in the session 1958-59. Particulars can be obtained from the head of the department.

Taking Care of People

Few industries have given as much systematic thought to safety propaganda as the iron and steel companies. They have had their reward. In 1958 all areas reported a better performance in the accident frequency rate than in 1957. Progress was uneven but it was real enough.

The British Iron and Steel Federation's occasional magazine *Safety* has just put out its fifth edition. It is an ambitious project in colour with a lively approach. Features range from the discussive and informative to the effective but grisly, like the safety officer who usually rattles glass eyes in his hand whenever he sees operatives grinding without goggles. On this occasion the magazine in one article looks beyond iron and steel to copper. An item of interest on the inside front cover is the latest quarterly accident frequency rate calculated by a punched card unit. The last quarter of 1958 saw the rate down to 2 per cent. Some 240 companies are now cooperating in producing this quarterly figure. They send in returns of the number of processes, maintenance workers employed, total manhours worked and accidents occuring in each department. The accident frequency rate is calculated for each company so that it can compare its results with the industry's average. But whatever the topic, the very existence of the magazine creates and augments the impression that the industry cares about people.

Inquiry on the Truck Acts

The Minister of Labour has appointed a committee to review the operation of the Truck Acts under the chairmanship of Mr. D. Karmel, Q.C. The law on the subject is complex and these Acts, originally passed to protect the worker to ensure honest money wages, now sometimes prevent the operation of benefits and amenities.

Pilot Training Scheme

It was announced in the House of Commons recently that a national college for airline pilots is to be established. At the College of Air Training, Hamble, cadets from about 18 will be able to take an intensive course in airmanship. The college will open in 1960 and will take over the facilities at present owned by Air Service Training Limited. A price for these has been agreed with the airline corporations. The college will be administered by a board of governors set up under a trust deed. Members will be nominated by the airline corporations and the Ministry of Transport and Civil Aviation. Representatives of the Ministry of Education and other educational interests will also be included. The independent airline operators will be represented.

The college has become necessary because the flow of pilots from the services will fall off in the next few years. In the first year the intake will be 50 cadets. For the four following years the maximum will be 100 a year so that in the third year onwards the college will have 220 cadets passing through it.

The State will contribute £1,000 per pilot trained with additional assistance while the college is becoming established. The sponsoring airlines will find the balance of some £3,000 per cadet. The annual state grant is likely at first to be of the order of £100,000 to £120,000 a year.

Scholarships on Target

The target set at last year's Montreal Conference for 1,000 scholarships and fellowships has now been reached. In addition to the 750 announced already by this country and Canada, 307 have been announced by other members of the Commonwealth. The attention of governments has been drawn to the need for organised reception and welfare.

Careers for the Ploughed

The figure is now time-honoured of the Bengali student complete with umbrella and name-plate "B.A. failed." Today, however, he is no longer a joke. The student who cannot get a degree has become an accepted social problem. It may be one of the luxuries of a high standard of living when the community worries itself about the student who cannot satisfy the examiners or it may be eloquent proof of the dearth of manpower. Whatever it may be, the undergraduate who failed is now raw material for survey work.

A limited survey by the University Grants Committee in its blue book, *University Development, 1952-1957*, found that 11·3 per cent of undergraduates failed academically. Surveys at individual universities, including Cambridge and Liverpool, produced even higher figures. Another investigation is going on at the London School of Economics which includes the question: Why do people fail? The answers are likely to be complex. Cases have occurred where some who have failed to graduate have done exceedingly well in their post-undergraduate careers. There are varied combinations of laziness, lack of capacity and unfitness which will probably be found in the answer.

Meanwhile, it is difficult to avoid the conclusion that a system which produces over 10 per cent of misfits in one form or another has serious shortcomings at the selection end.

Education for Commerce

The recommendations of the Advisory Committee on Further Education for Commerce who, under the chairmanship of Mr. J. G. McMeeking, reported last March, were warmly commended and accepted by Mr. Geoffrey Lloyd, Minister of Education. The report emphasised the need for a national effort in the education and training of young people for commercial posts comparable with the effort now being put into scientific and technological education. Educational authorities have been urged to implement the recommendations which specially concern them, particularly with regard to staffing the colleges and the development of new educational courses.

Mr. Moonman in Orbit

The British Institute of Management are sending their human relations adviser, Mr. Eric Moonman, to the United States at the end of this month for a 2 months' tour. He will give lectures, take part in television programmes and meet a large number of personalities in the US and Canada connected with management and human relations problems. In short he will learn and show the flag on behalf of the BIM.

His itinerary, which looks like being as exacting an ordeal as most of its kind turn out to be, indicates the wide range of interests which today concern themselves with human relations in industry. Mr. Moonman's tour includes meetings and discussions with authors, novelists, trade union officials, research directors of trade unions, university departmental heads, management associations and institutes of human relations. His tour is itself sponsored by the European Productivity Agency with which the BIM has its own contacts and procedures for obtaining a cross-fertilisation of ideas. The tour has been arranged from US Counterpart Aid.

One of the features of the arrangement is that Mr. Moonman goes from a personal background where personal experience has probably been at least as important as academic training. Mr. Moonman is to meet a number of authors: Mr. William H. Whyte (*The Organisation Man*), Mr. Peter Drucker (*Future of Industrial Man*), and Mr. David Karp, who wrote the devastating novel *One*.

Paintwork

An exhibition of paintings of buildings and civil engineering subjects carried out for John Laing and Son by Terence Cuneo was held in London from 29 June to 10 July. Twenty-two paintings were on show, each of different major schemes at various stages of construction. The effect was most striking, combining naturally, as Cuneo appears to do, artistic merit with industrial realism.

FLASHES OF BRILLIANCE AT THE FRENCH ELECTRAMA

Recent discussions with French engineers and more particularly a visit to the first all-embracing electrical engineering exhibition held in France, —the "Electrama" project, has allowed some re-assessment of the place of the French electrical engineering industry in the world as a whole.

By J. H. M. Sykes

It may sound strange that all that we in England mean by the "Gallic spirit" can find its way into heavy power engineering, but that this is so was in fact strongly felt at the Electrama exhibition.

There was to be found in many quarters a degree of daring and a novelty of approach which was refreshing and stimulating to the eye of the engineer accustomed to more stolid designs of heavy electrical plant; and it must be added that most types of equipment were of materials of lighter section than would generally be considered as standard.

The electrical manufacturing industry in France employs about 263,000 workers (compared with 710,100 in Great Britain). There are about 1,830 firms with more than five workers. The total orders received in the twelve months up to April, 1959, reached 877·5 milliards of francs, about £650 million. Of this figure, 10·3 per cent is destined for export—a considerably smaller proportion than in Great Britain.

Discussing these figures, an engineer from a leading French manufacturing concern said that it was hoped that the European Common Market would provide an outlet for the French electrical engineering industry in the particular direction in which they had long felt rather frustrated. The volume and extent of electrical engineering research in France has tended to be somewhat greater than normal progress would warrant: in other words, there have been more ideas and experimental projects than either the finances or the needs of the customers could accommodate.

The wealth of ideas and invention in the minds of French engineers may be illustrated by references to the Abidjan sea-water temperature difference scheme (ENGNG., vol. 186, '58, p. 104); the tidal power projects on the Rance (ENGNG., vol. 184, '57, p. 343) associated with the Isles de Chaussey; the 4,000 kW wind generator now being discussed; and other projects still in the unrealised stage: but there are many other projects where the volatile brains of the French designers have hit on schemes which are now beginning to be of increasingly practical value both for home and export use. The bulb-type hydro-generator and the suspended circuit breaker form two examples.

It was learned in Paris that the opening up of a wider market may enable the advanced ideas of French designers to find more rapid application.

The Electrama exhibition included 500 stands. It was held in the newly built Palais des Industries et des Techniques, a magnificently conceived structure of reinforced concrete, with the largest arch in the world, supported only at three points 654 ft distant from each other. The exhibition was remarkable especially for the number of full scale exhibits, and among those taking pride of place was the Delle exhibit on the large composite stand of the Compagnie Générale d'Electricité. This comprised one pole of the highest voltage circuit breaker yet made anywhere in the world. It was designed for 525 kV, and was some 30 ft high.

This air blast breaker takes the form of stacks of interrupters made up into two columns, each mounted on a remarkably slender framework consisting of three supporting insulators. The current enters the lower end of one stack, rises through the four interrupters on one stack, through the connecting bar, and down the four interrupters on the other stack.

A novel pantograph-type "sectionneur," or isolator, also for 525 kV, was seen on the Delle stand. The mechanism is supported on two post insulator columns, and the rotation of one of them, by motor or hand operation, causes a pantograph-type structure to ascend or descend up to or away from the fixed point connectors on the busbars, and at the same time to open out (when making contact) so as to press the contact pieces into position. It might be thought that there would be some operating problems arising from the extensive and lengthy linkage involved, particularly if icing-up of the contacts should take place, or if some degree of corrosion had introduced additional frictional loads. The general lightness of the structure of both circuit breaker and isolator seemed a little daring to British eyes, perhaps accustomed to exceptionally high factors of safety.

In the range of 525 kV gear there was an exhibit from the Savoisienne company showing parts of a 525 kV auto-transformer in the course of construction, and Cables de Lyon showed a 525 kV cable sealing terminal—an impressive piece of brown glazed porcelain.

All this 525 kV development has been made possible by the receipt of orders from the USSR for equipment to raise the transmission voltage of the Russian main grid lines from 400 kV to 500 kV. The fact that the French supply authority, Electricité de France, had commissioned its first 380/400 kV line (Genissiat-Plessis-Gassot, 446 km) in 1958 enabled the Russian engineers to have a choice of Swedish, West German and French designs of high voltage gear, since only in those countries could a higher level than 330 kV be seen actually at work. But for reasons mentioned earlier the French engineers had experimented ahead of their time with light yet robust designs of high voltage gear and had (presumably) made them at highly competitive prices. The close collaboration that exists between the manufacturers and the supply authority has enabled network tests of a most exhaustive nature to be carried out at the famous Fontenay testing station, where there exists unique facilities for applying actual system loads to large scale plant under experimental régimes.

The fruit of this forward looking attitude, coupled with close collaboration with the supply authority, is seen in this extensive Russian order, the exact extent of which was not revealed: but it is in passing interesting to note that after Western Germany (6·58 per cent) the largest proportion of French electrical exports is directed to the USSR, at 4·78 per cent, compared with only 2·11 per cent to the desirable dollar market, and 1·36 per cent to Great Britain.

The greatest advantage that may well accrue to France as a result of the development of 525 kV gear for Russia is not only the import payments but the incalculable prestige value of having been the first country in the world, outside Russia herself, to manufacture gear for what will undoubtedly take its place as the next standard voltage level. Those responsible for major schemes like the Snowy Mountains project and the Kariba dam scheme, now employing the 330 kV level, will undoubtedly give very serious consideration to the use of 500 kV when schemes on a similar scale are projected in the future, and they must then inevitably become strongly attracted towards French equipment. A Swedish firm pioneered the use of high voltage direct current equipment, with the collaboration of the State Power Board, and for some years to come any organisation needing this type of equipment can scarcely purchase it elsewhere. The Channel cable gear is being bought from that company, and if the New Zealand Cook Straight crossing scheme goes forward it is almost a foregone conclusion that the same Swedish source will receive the contract.

The lesson to be learned seems plain: not only must research be carried out—and all electrically developed countries have in any case extensive research programmes—but in addition it must be pushed, in collaboration with the users, to the stage where designs of plant not immediately required can be tested under working conditions.

The Electrama exhibition included a striking demonstration of the way in which transformers for more commonly employed voltages than those mentioned above. The Savoisienne stand had

two transformers on it, both full size for 63/16·5 kV, with a normal rating of 20 MVA. It was difficult to believe this because, one built in 1959 appeared to be less than half the size of the other, built in 1952. Recent progress in the rather mundane field of transformer design, where it might be thought that little really new had evolved since Faraday's time, was demonstrated extremely vividly in this way. The weights and sizes of the two units are given below (both transformers were fitted with on-load tap-changers):

Comparison of Transformer Dimensions.

—	1952 design	1959 design
Overall length	7,250 mm	4,000 mm
Overall width	4,950 mm	2,550 mm
Overall height	7,550 mm	3,500 mm
Total weight	73 tonnes	26 tonnes
Weight of oil	20·5 tonnes	5·3 tonnes

The main features of design which have led to this very marked reduction in weight and dimensions over a period of seven years are as follows: the use of grain-oriented magnetic steels, gaining 35 per cent in weight, and incidentally reducing the no-load losses by 26 per cent; the adoption of forced cooling instead of natural circulation; the reduction in the sizes of the winding coils and their insulation, in the light of greater knowledge of stress distribution under impulse tests; and the adoption of a streamlined tank, in the form of a base on which the windings are completely erected, and to which a light cover is welded.

It is of course possible that in other countries a demonstration of the reduction in transformer dimensions achieved over seven years could show an even more striking comparison: but a Swedish engineer at the Electrama told the writer that neither in the United States or anywhere else had he actually seen the comparison made. The impression of buoyant progress in transformer design left on the mind of the potential overseas purchaser must have been very great.

The dash and élan which French engineers bring to heavy power engineering was exemplified some years ago, in 1955, when they set their CC7107 and BB9004 electric locomotives to break the railway speed record, and succeeded in both cases in reaching 205 m.p.h. on the Bordeaux-Dax line. In demonstrating the layout of these locomotives at the Electrama, they mentioned that, with the 25 kV 50 c/s system their catenary

Visitors clustered round a working reactor core exhibit.

wires were "the lightest in Europe." There was a time, not long ago, when British railway engineers would have proudly claimed that any item of equipment they installed was "the heaviest in Europe."

In the railway field, a relatively new departure was the Alsthom single motor bogie, with gear changing for freight or passenger service. This scheme, demonstrated on a full size bogie at the Electrama, is claimed to have a number of advantages. The coefficient of adhesion at the vital slow speeds of up to 15 m.p.h. is said to be increased by 15 per cent, and the adoption of a single motor on each bogie itself reduces motor weight by 20 per cent, while a further 25 per cent reduction in motor weight is achieved by the use of the gearing, by using the same motor for the 60 m.p.h. freight service régime and for 93 m.p.h. passenger service.

Those who attended the first United Nations conference on the peaceful uses of atomic energy at Geneva in 1955 will recall the deep impression made on the hundreds of thousands of people who first saw a nuclear reactor actually at work. The swimming pool reactor in the grounds of the Palais des Nations had a powerful effect on public opinion, since the quiet, safe pool had a reassuring effect: the lurking fear that all reactors were dangerous was at once removed.

In the case of the PEG pile at Electrama, set up by the Commissariat à l'Energie Atomique in the centre of the hall, the French had exposed the very core of this ½ watt enriched uranium light-water cooled reactor, so that on a spiral ramp encircling the core the thousands of spectators could peer closely into the lighted water, and see, on the instrument panel, the exact effect of raising or lowering the control rods. This was a most effective means of demonstrating the basic principles of nuclear fission to young engineers, to specialists in other fields, and to the general public. An engineer from the General Electric Company, USA, told the writer that he was proposing to pass on to his colleagues in America the PEG demonstration reactor idea, since nothing quite like it had so far been attempted in the United States.

It would be idle to catalogue the outstanding exhibits at Electrama—the proton microscope, the electronic telescope, the electronic telephone exchange, and many others. The overall impression of talks with many French engineers was that the French electrical manufacturing industry, given the greater scope for its sometimes brilliant ideas offered by the Common Market may well receive such an impetus as to transform it into a most serious competitor with the United States or Britain for world markets of every kind.

STRUCTURAL DESIGN BY MODELS

For many engineering structures—particularly some of the new architectural forms—design calculations are based on questionable assumptions, or no theoretical treatment at all is available. In such cases scale models can yield equal or even better information. Indeed, many designs would benefit if authorities would accept model analyses from reputable laboratories as they now accept calculations.

THERE has been an increasing activity in the field of model analysis of structures during recent years, and this led up to a Colloquium on Model Structures being held in Madrid between the 22 and 25 June this year. The sponsors were the International Union of Testing and Research Laboratories for Materials and Structures—RILEM as it is known from its French abbreviation—and the hosts for the meeting were the Instituto Technico de la Construccion y del Cemento and the Laboratorio Central de Ensayo de Materiales de Construccion. The meetings were held in the very modern and comfortable premises of the former organisation on the outskirts of Madrid.

To narrow the discussion it was decided to exclude photoelasticity and any experimental methods which relied on an analogy between the structure studied and some other physical system. It was felt that the latter topics were adequately covered by various societies for applied mathematics.

The business of the colloquium was divided into five sessions dealing with the following aspects of model analysis: (1) conditions of similarity between model and protype; (2) construction of models; (3) loading of models; (4) quantitative determination of strains; and (5) interpretation of results and their practical applications.

Altogether 36 papers were submitted. Their distribution among the participating nationalities is of interest: eleven were submitted from France, ten from Portugal, five from Germany, three from Italy, two each from the United States and the Soviet Union and one each from Britain, Spain and Switzerland. These figures clearly show where the centre of interest in model analysis lies.

The first session was concerned with the principles of similitude as applied to the model and the prototype. The importance of clear thinking on this subject was emphasised and methods employing dimensional analysis were illustrated for static and dynamic problems in linear and non-linear elasticity.

A highlight of the session was a reconsideration by Mr. M. Rocha (Lisbon) of the concept of the factor of safety for a structure, such as an arch dam, where by the nature of things high overloads were impossible. Here failure, it was pointed out, could result only from a weakening of the structural material. Hence the factor of safety could be considered as the ratio between the actual strength of the prototype material and the reduced strength of the material necessary to bring about collapse.

To determine this factor of safety from model tests an intelligent estimate had to be made, in the first place, of the stress-strain relation expected to cause failure of the prototype material. A model material had then to be proportioned to reproduce this stress-strain relation to a scale ensuring reliable measurement of strains in the laboratory. By applying discrete forces to its surface a model made of this material could then be loaded to destruction.

In tests carried out in Portugal on arch dams these boundary forces were made to act in the direction of the resultant of the hydrostatic and gravity forces on each element they were considered to replace statically. If the prototype material strength, equivalent to the failure loading of the model, indicated that the assumed shape of the stress-strain curve was incorrect a second model made from a modified material was made and tested.

The second session considered the problem of model manufacture, and dealt with the choice of model scales and materials as well as with the actual methods of construction.

It was appreciated that two opposing considerations affected the choice of model scales. From the point of view of the model analyst a larger model was always more convenient since it simplified the problem of loading and strain measurement. The interests of the promoter, however, were in the economy of time and money which tended to result from a smaller model. Compromises between these two interests had to be made. In Portugal, it was reported, model studies of arch dams have been made to scales of 1/300 to 1/200.

LOADING TECHNIQUES

Choice of model materials gave rise to a lively discussion. The model material that satisfied all the laws of similitude, and at the same time possessed all the virtues demanded of it in the workshop and laboratory, was found to be very elusive; even more so if the problem of body forces was introduced. A number of delegates who had had a lot of experience of model analysis were opposed to the use of rubber models and "frozen-stress" photoelasticity on the grounds that the high value of Poisson's ratio involved violated the laws of similitude (Poisson's ratio for rubber is nearly 0·5 while that for concrete is 0·15 or less). It was agreed that the importance of this factor could not be assessed for all cases without further research. Work done on this problem in Britain, however, indicated that such variations of Poisson's ratio tend to have insignificant effects on the stresses. In considering model materials distinction was, of course, drawn between rupture tests and ones involving working loads only.

The third session dealt with the application of loads to the model. Needless to say, a wide variety of loading systems were described by the delegates. A method of loading a Perspex model of a bridge to determine influence lines by the application of fixed displacements was presented by a speaker from Southampton University. Portuguese engineers reviewed critically the existing techniques for studying the effects of body forces in dams. Inadequacies in the accepted methods led them to adopt a different approach, namely that of constructing the model in stages. In this way an attempt was being made to reproduce on model scale the actual conditions under which gravity stresses were developed during the construction process. The static effect of the weight of each lift of concrete was replaced by an equivalent external

SIX BRITISH DESIGNS WHERE MODELS WERE USED

The Cement and Concrete Association have been using models to obtain solutions to structural problems for which no theoretical analysis was available. In particular they have been using this technique to assist consulting engineers and a description of some of these models was given recently by Mr. R. E. Rowe, M.A., A.M.I.C.E., head of the structures research department of the C and CA. He was speaking at a one-day symposium "Models for Structural Design" sponsored by the Association and held at the Institution of Civil Engineers on 29 July last.

Clifton Bridge, Nottingham.—The prestressed concrete Clifton bridge is a balanced cantilever with a suspended central span of 275 ft designed by R. Travers Morgan and Partners. A skew of 24° restricted the value of conventional methods of analysis so a perspex model of $\frac{1}{50}$ scale was made and tested. The model made it possible to determine (*a*) the shear centre of the abutment end for various loads, and therefore the distribution of load among the support columns; (*b*) the general distribution properties of the bridge; and (*c*) the effect of prestress, which was very eccentric, on the deformation of the cantilever. This information was basic to the detailed design of the bridge.

End Blocks.—To resolve difficult end block problems plaster models have yielded information regarding the formation of cracks, and thereby indicated the required distribution of reinforcing steel. A typical example was an end block for a severely skewed (70°) railway box bridge. The shape of the end block required the prestress to be divided between groups of anchorages acting on different faces along the line of skew. A model clearly indicated the stress formations that had to be countered.

Shell Roof for Garage.—The shell portion of a garage and showroom designed by Mr. K. Hajnal-Kónyi consisted of a group of four hyperbolic paraboloids, each square in plan, in two groups with a glazing strip between them. The high points at the four corners of the structure were supported by tubular steel columns. The rise along each edge beam was 14 ft 6 in and the lower corners were joined by a pretensioned T-beam cast with the shell. It was required to find the effect of the tie beam on the shell stresses and the stresses due to loading. A $\frac{1}{10}$ scale model was made in reinforced mortar which was tested with a uniform load; deflections and strains were recorded. Finally the shell was loaded to destruction.

Bedford Factory Roof.—A $\frac{1}{6}$ scale model, with a $\frac{1}{8}$ in membrane, was made of a shell design by Oscar Faber and Partners. The prototype was 48 ft square and supported at its centre, one of 33 shells forming a factory roof. The information required was primarily the deflection of the shell under uniform and eccentric snow loading, and a general indication of stresses in the edge beams, compression members and membrane. This information was obtained in a relatively short time using the model.

Medway Bridge.—The proposed Medway bridge has two 200 ft cantilevers with 300 ft tail spans and a 100 ft suspended span; it has been designed by Freeman, Fox and Partners. The section of the cantilevers varies considerably, making impossible analysis of the distribution that occurs under live loading. A model of about $\frac{1}{14}$ scale in prestressed concrete has been used to investigate the live load stresses and actual stresses in the deep slender webs under combined loading. The investigation is still in progress.

Hammersmith Flyover.—The flyover consists of hollow spine beams of 140 ft span, continuous over many supports, with precast cantilevered diaphragms to give a 61 ft width of bridge. The cantilevers support precast slabs and an *in situ* screed forming the carriageway. With only two lanes loaded, combined bending, torsion and shear result in the spine beam at the pier. The designers, G. Maunsell and Partners, wanted to check their elastic calculations and to find out the manner in which the structure would fail. A $\frac{1}{12}$ scale model is now under construction to give this information.

As will be seen from our correspondence columns this week the Cement and Concrete Association are offering to make and test structural models at their Wexham Spring laboratories on a cost basis. Further details can be obtained from Mr. A. W. Hill, the association's deputy director of research, at 52 Grosvenor Gardens, London, SW1.

load at the homologous point on the model which was gradually built up or, as was more convenient in practice, gradually cut down. By summation of the differential strains recorded at a given point during this process the required stress was obtained.

Two interesting cases of dynamic loading of models were reported. Engineers from Bergamo (Italy) described tests to destruction on an arch dam which together with its impounded reservoir was subjected to acceleration forces of varying intensity and frequency. This research had been undertaken following an inquiry from Japan.

A research team from the Massachusetts Institute of Technology reported that they had also been concerned with the effect of shock waves on structural elements. Their experiments were carried out in two stages. In the first a small model was placed in a shock tube where the pressure variation with time was recorded over its surface. In the second stage mechanical and electronic devices were constructed to apply these pressure variations to a larger model on which strain measurements could be made.

The standard methods of surface strain measurement, such as the use of resistance strain gauges, extensometers, brittle lacquers and grids, were the subject of the fourth session but nothing new materialised.

The final session, on the practical application of models, gave the delegates an opportunity to survey the work of the previous sessions and to draw more general conclusions. Having looked back on past achievements in the field of model analysis the delegates turned to the future and especially to the relation between the model analyst and the theoretician. Events have shown that the complexity of structures proposed by architects increased yearly, taking little note as to whether satisfactory analytical methods for their design existed. As examples one could quote the Opera House at Sydney, Australia, or the Jinnah Mausoleum in Pakistan. In other instances the lack of theoretical approach have resulted in highly uneconomical structures. It was felt that in such cases model analysis had much to offer.

MODEL AUTHORITY

The delegates were in agreement that in the present state of model analysis the results thus obtained had an equal claim to accuracy with those derived from theory. The attitude of mind that under all circumstances demanded analytical checks for model results was considered to be out of touch with reality. It was recognised, however, that the fundamental laws of equilibrium had to be constantly borne in mind in the interpretation of results from models.

It was stressed that good results could not be expected from laboratories turning sporadically to model tests only when the occasion arose. Maintaining a specialised staff and costly equipment made continuity of work essential, and this in turn depended on the attitude of the engineering profession—and public authorities—to model analysis. This attitude, which varied from country to country, was ultimately reflected in the official regulations and codes of practice governing design procedures. In some countries results of model tests carried out by reputable laboratories were accepted for design purposes. In others, they were accepted only when they strove to confirm the results of some calculation, however dubiously formulated. As was to be expected, the more model-conscious codes existed in countries where the usefulness of model analysis has had ample demonstration.

As with most small gatherings (there were only 70 delegates) the colloquium served the most useful purpose of providing the opportunity of making or renewing personal contacts. Some of these have resulted in plans for active collaboration between laboratories. Without hesitation it can be said that the colloquium was a great success. It not only brought together a wealth of technical information but also made a useful assessment of the present and future position of model analysis in the field of structural engineering.

Heavy Duty Floor Tiles

A new industrial floor tile, Diametile, has been introduced by Jaconello Limited of 18 Howick Place, London, SW1. A specially hard aggregate ensures non-slip qualities under nearly all conditions. Well suited for undertakings where fatty acid spillage occurs, the aggregates are bound with an aluminous cement which is resistant to such attack.

Roof Bolts in New Water Tunnel

Roof bolts are being used to support all 44 miles of New York City's West Delaware water tunnel now under construction. Specifications call for 1 in split wedge bolts driven to a depth of 6 ft and tightened with a calibrated wrench to at least 200 ft-lb torque. The bolts are said to each take a 40,000 lb pull in hard rock. The tunnel is 11 ft 4 in in diameter and cut through a fairly uniform Devonian shale and sandstone.

Flow Rates in Aluminium Pipes

Because of the increasing use of aluminium pipe and tubing for fluids, a need has grown for hydraulic coefficients for this material. A long-term investigation being carried out by Mr. J. S. Campbell, MEIC, and Mr. A. Brebner, both of Queen's University Kingston, Ontario, is reported in the *Transactions* of the Engineering Institute of Canada for April 1959 (vol. 3, No. 1).

Friction coefficients are given for 2, 4 and 6 in new aluminium pipes in part 1 of the paper; the efficiency of such pipes after years of service is discussed in part 2; and in part 3 probable losses are given for standard fittings for 2 and 4 in pipes. Each part contains a theoretical treatment and tables of the experimental results which are also presented in graphical form.

Irregularities in Asphalt Road Surfaces

A Blaw-Knox PF-90 paver, owned and operated by Amey's Asphalt Company Limited has been used to lay 93,000 tons of hot rolled asphalt in 10 months on an airfield contract. In a series of riding quality tests, along 1,200 ft strips, conducted by the Air Ministry, an irregularity coefficient q (sum of all irregularities greater than 0·1 in) of 9 in per mile was found on one strip and an average of 15 in per mile based on a total test length of 8 miles. This compares with a value of 20 in which was the best measured previously. The PF-90 machine is mounted on pneumatic tyres, has a long wheelbase and a fully floating screed. The Blaw-Knox Express paver is now fitted with a pneumatic control system to regulate the flow of material to the screed.

Prefabricated Aluminium Roofs

An aluminium alloy roof, for houses and small buildings having spans of 20 ft to 30 ft, has been developed by Coseley Buildings Limited, Lanesfield, Wolverhampton. The trusses, beams and sheeting are fabricated as an integral unit. Truss spacings can be varied from 10 ft to 40 ft, depending upon loading; normal spacing is 20 ft. Each roof is despatched as a " packaged deal," prefabricated and ready for erection.

State Construction in New Zealand

The New Zealand Ministry of Works' annual statement has been published for 1959, showing that expenditure on State works is currently £82 million per annum. It is noted that this figure will have to be increased to meet demands of a growing population. Last year saw an increase in river protection and soil conservation works; high priority for river control schemes is advocated.

For power development, the Government are considering the North and South Islands separately but the possibility of linking the two systems is being examined. The power potential in North Island has been found to be much higher than previously estimated.

Snowy Mountain Tunnel Completed

The Eucumbene-Tumut tunnel, a principal section of the Snowy Mountain hydroelectric project in Southern Australia, has been completed—nearly four months ahead of schedule. Costing £A14 million, the tunnel will carry the first major diversion of water through the Great Dividing Range, transferring melting snowfields in the Australian Alps to the recently completed T1 underground power station. Discharge from the station will be used to irrigate the plains further west.

The tunnel is 14 miles long and 21 ft in diameter. Driven through granite, it ranks as one of the biggest tunnelling jobs ever undertaken. During one period of six days the face was advanced 484 ft.

Tenders Let for Motorway Viaduct

Contracts worth nearly £7·5 million for three viaducts along the Birmingham-Preston-Penrith motorway have been let. The Thelwall viaduct (£5¼ million) will be built by Leonard Fairclough Limited, Adlington. It is 1¼ miles long and has 36 spans; the longest span, over the Manchester Ship Canal, will be 336 ft long and will be of riveted steel construction.

The other two contracts are for the Creswell Viaduct and the Gathurst Viaduct and have been let to J. L. Keir and Company Limited of London, and A. Monk and Company Limited of Warrington, respectively.

New Dredger for Scottish East Coast Ports

British Transport Docks ordered from Seawork Limited, London, a twin-grab diesel hopper dredger for use mainly at the ports of Grangemouth and Methil, where over 400,000 tons of spoil require to be removed each year from the docks and their approaches.

Details of the new vessel, which will replace several obsolete craft, are: length, 190 ft; breadth moulded, 37 ft; depth moulded, 16 ft; and carrying capacity, 1,200 cu. yd.

This Year's Civil Engineering Scholarships

The names have been announced of the 17 successful applicants for awards under the Civil Engineering Scholarship Trust, sponsored jointly by the Institution and the Federation of Civil Engineering Contractors. The scholarships have values between £200 and £450 per annum and are tenable for three years. Eleven of the scholars are going up to Cambridge, and two each to London, Bristol and Nottingham. The Trust received about 100 applications, which are described as being of a " generally high standard."

Coloured Cements and Exposed Aggregates

A new series of display walls and frames showing concrete as a facing material has been erected by the Cement and Concrete Association at their laboratory at Wexham Spring, near Slough in Buckinghamshire. The panels indicate the range of patterned and exposed aggregate finishes available.

Terraces have been laid out to show how precast and *in situ* paving in various colours and finishes can provide decorative settings for both public and private buildings.

Stored Energy

THE mood of discouragement which has beset the atomic energy industry for more than a year shows signs of passing. Companies are beginning to readjust their plans to the new situation, and the power programme may not prove the economic hazard that it has come to seem. The Atomic Energy Authority, with the publication of its latest report, has completed its period of rethinking and consolidation, and carries a new air of vitality and confidence. The vexed question of ship propulsion is being tackled frankly, and is likely to be resolved in a satisfactory manner. Safety administration has undergone an exhaustive review, leading in the long term to an improvement in public morale. The Authority's policy on certain exotic reactor systems has recently been vindicated by United States decisions to discontinue work on similar reactors; and the proposal to undertake ICSE (intermediate current stability experiment) represents a prudent return to fundamentals in thermonuclear work. The visit of a British team to see a Soviet experimental fast reactor shows that we are still prepared to learn. The background to this revival is sketched in the following collection of notes.

NPPC and AEI-JT Collaborate

Negotiations have been in progress for some weeks between the Nuclear Power Plant Company Limited (NPPC) and the AEI-John Thompson Nuclear Energy Company Limited with a view to arranging collaboration between the two companies in nuclear matters, and it has been decided that collaboration shall take place. The two companies have informed the chairman of the CEGB of this decision and negotiations are continuing with a view to settling the details. It is the immediate intention of the two companies to submit a joint tender for Dungeness power station based on a common design and a similar procedure will in due course be followed for Sizewell power station.

Trawsfynydd Nuclear Power Station

As reported in Atomic Review on 19 June, the Central Electricity Generating Board have issued a letter of intent to Atomic Power Constructions Limited to enter into a contract for the design, construction and commissioning of a complete 500 MW nuclear power station at Trawsfynydd in North Wales. The contract also includes a development scheme for Portmadoc Harbour, which will enable many of the heavy items of plant and equipment to be sent to the site by sea. The design provides for two natural uranium, graphite moderated, gas cooled reactors. The arrangement of a similar reactor designed by APC appeared in Atomic Review on 28 March, 1958. The site is situated within the North Wales National Park and therefore the most careful consideration has been given to the design of the buildings. Mr. Basil Spence is architectural consultant for the project. Details of the reactors are tabled below.

Data for Trawsfynydd Nuclear Power Station

Guaranteed output:	500 MW
Installed capacity:	4 × 145 = 580 MW
Reactors	
Number:	Two
Heat output, approx.:	2 × 870 MW
Moderator, dimensions:	48 ft across flats by 27 ft 6 in high
approx. weight:	1,900 tons

(Machined graphite blocks held by circumferential restraint members; the moderator structure is supported from a fabricated steel grid carried on pillars and struts from the inner skirt of the pressure vessel; differential expansion between the moderator and its support is accommodated by a series of ball thrust races.)

Fuel:	natural uranium
Fuel charge, approx:	280 tons
Number of fuel elements per channel (end to end):	9
Number of fuel channels (vertical):	3,720

(The diameter of the fuel element channel is constant throughout the core; channels outside the flattened zone are gagged to ensure that heat is removed at the highest gas outlet temperature.)

Lattice (square) pitch:	7¾ in
Fuel:	natural uranium
Charge, approx.:	280 tons
Canning:	magnesium alloy
Can temperature, approx.:	440° C

(The can has extended surface and four longitudinal alloy splitters to centralise the element in the channel.)

Pressure vessel (spherical) internal diameter:	61 ft

(5 ft 6 in smaller than the pressure vessels at Hinkley Point.)

Pressure vessel thickness:	3½ in

(A circumferential gas seal is fitted between the pressure vessel and the graphite structure.)

Coolant:	carbon dioxide
Coolant pressure:	240 lb per sq. in g
Coolant inlet temperature, approx:	200° C
Coolant outlet temperature, approx.:	400° C
Mass flow	9,000 lb per sec
Coolant ducts, diameter:	5 ft 6 in

(The ducts incorporate expansion bellows and isolating valves.)

Heat Exchangers

Number per reactor:	6

(Placed in line in two groups of three on opposite sides of the pressure vessel.)

Heat exchanger shells, height:	116 ft
internal diameter:	18 ft
plate thickness:	2½ in

(Dual pressure steam cycle, 65 per cent of the steam being generated at the high pressure.)

Gas Circulators

Number per heat exchanger:	1

(Extra single-stage axial-flow fan located vertically beneath the heat exchanger.)

Power consumed per circulator:	6,000 h.p.

(A constant-speed drive is incorporated, comprising an induction motor running at 2,950 r.p.m., coupled directly to the circulator; during operation the gas flow is regulated by linked throttle valves in the main gas ducts and bypass valves in the recirculation ducts.)

Reactor Building

Dimensions:	300 ft by 180 ft by 179 ft high

(Each heat exchanger with associated gas ducts is separately shielded along its entire length by shield walls connecting with the reactor biological shield; at boiler plinth level the building is extended to form a common circulator house.)

Thermal shield:	none
Biological shield:	high density concrete

Fuel Handling

Weight of each charge-discharge machine:	380 tons
Height:	64 ft

(Machines are composite units capable of performing all operations connected with the fuel handling system on the charge face, and are designed to operate while the reactor is on load; normal control is by remote operation but provision is also made for local control.)

Control and Instrumentation

Control rod material:	boron
Number of automatic control loops per reactor:	two

(One loop is primarily intended to eliminate instabilities in the reactor neutron flux; the other is used for adjusting the reactor output to meet load requirements; provision is made for fully automatic control of the station, and safety measures include special emergency shutdown devices; the central control room is situated between the two reactor buildings.)

Generating Plant

Turbine house dimensions:	450 ft by 220 ft
Maximum continuous rating per turbogenerator:	145 MW

(The turbogenerators, which have water-cooled stator windings, are four-cylinder machines designed for a dual pressure steam cycle; steam is discharged through six exhausts into twin condensers.)

Steam Conditions at Turbine Stop Valve

High pressure steam:	927 lb per sq. in g and 715° F
Low pressure steam:	290 lb per sq. in g and 685° F
Steam flow, high pressure	6 × 290,000 lb per hour (65 per cent)
low pressure:	6 × 155,000 lb per hour (35 per cent)

(A Goliath crane 250 ft span and lifting height 200 ft will be used to lift loads up to four hundred tons weight; work began on 1 July, 1959, and the station is due to be in operation in 1964.)

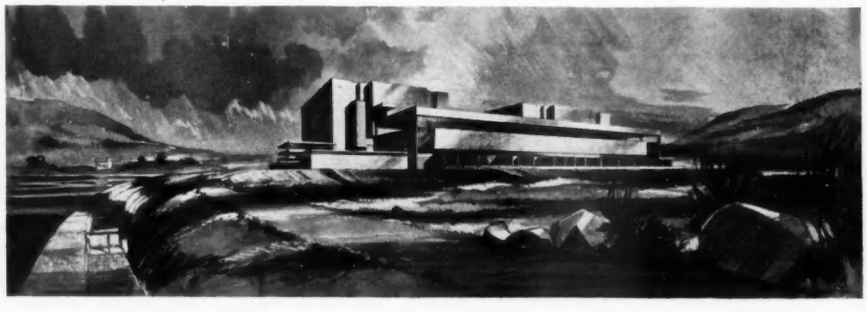


Fig. 1 Impression of the projected nuclear power station at Trawsfynydd. The station is being built by Atomic Power Constructions Limited for the Central Electricity Generating Board.

Atomic Power Constructions

Atomic Power Constructions Limited, which was formed at the end of 1956, now comprises: Crompton Parkinson Limited, Fairey Aviation Limited, International Combustion (Holdings) Limited and Richardsons Westgarth and Company Limited, in association with Nuclear Civil Constructors. NCC is a partnership of Trollope and Colls Limited and Holland & Hannen and Cubitts Limited; it operates exclusively for APC.

Dungeness Consent

Consent for the erection of a 500-550 MW nuclear power station at Dungeness has been granted to the Central Electricity Generating Board by the Minister of Power.

Director of Berkeley Laboratories

Dr. C. P. Haigh, B.Sc., Ph.D., F.Inst.P., has been appointed director of the Berkeley Nuclear Laboratories of the Central Electricity Generating Board as from 2 May, 1959. In 1956 Dr. Haigh joined the staff of the Central Electricity Generating Board as head of the physics section of the Nuclear Development Branch, the post he now vacates to take up his present appointment.

A Larger Atomic Energy Authority

Section 1(2) of the Atomic Energy Authority Act, 1954, provides that there shall be not more than ten members of the United Kingdom Atomic Energy Authority, apart from the chairman. In this connection, the Prime Minister recently told the Commons that, owing to certain changes in the organisation of the Authority, there would be advantages in an increase in this maximum number. There was unlikely to be an opportunity of presenting the necessary amending legislation during the course of the present session of Parliament, but the Government hoped to do so at the beginning of next session.

Three UKAEA Appointments

Chairman.—The Prime Minister has appointed Sir Roger Makins, G.C.M.G., K.C.B., to succeed Lord Plowden as chairman of the United Kingdom Atomic Energy Authority, as from 1 January next. Sir Roger, who was educated at Winchester and Christ Church, Oxford, took first-class honours in history in 1925 and was called to the bar in the Inner Temple in 1927. He entered the Government's service at the Foreign Office a year later and, since 1956, has been Joint Permanent Secretary to the Treasury.

Member for Weapons.—The UKAEA have announced the appointment of Air Chief Marshal Sir Claude Bernard Raymond Pelly, G.B.E., K.C.B., M.C., as member (designate) for weapons. Air Chief Marshal Pelly, who is retiring from the Royal Air Force, has been controller of aircraft at the Ministry of Supply since 1956. He will take up his new appointment later this year. Sir William Penney's appointment to succeed Sir John Cockcroft as Authority Member for Scientific Research has already been announced.

Thermonuclear Director.—The UKAEA have appointed Mr. J. B. Adams to be director of a new establishment to deal with controlled thermonuclear research. The work in this field now being carried out at Harwell, and some work at AWRE, Aldermaston, will be moved to the new establishment. Mr. J. B. Adams is at present director of the proton-synchrotron group of the European Council for Nuclear Research (CERN) near Geneva. He will take up his appointment with the Atomic Energy Authority towards the end of 1960. The site of the new controlled thermonuclear research establishment has not yet been decided.

Safety and Insurance

Nuclear Installations Act

The purpose of the Nuclear Installations (Licensing and Insurance) Act which received the Royal Assent in July, is to ensure that nuclear installations on land are made subject to whatever controls are necessary in the interests of safety, and that their owners make proper provision for paying compensation, if anyone suffers injury or damage by radioactivity. The licensee will be required to insure his liability or show that he is holding adequate liquid assets. The liability is, however, to be limited in effect to £5 million in respect of any one incident, and actions may be instituted up to 30 years following an incident. The chance that damage will ever approach this figure is regarded as extremely remote, and in that case Parliament will make special pro-

vision. The cost of compensation following the Windscale accident was less than £100,000. The construction and operation of nuclear reactors, and any other nuclear installations which may be prescribed by regulations, will require a licence from the Minister of Power (in Scotland the Secretary of State) who may impose such safety conditions as he thinks fit. He will have the power to recruit an expert staff of inspectors to assist him in determining the conditions and in seeing that they are carried out. Major-General S. W. Joslin, successively the Atomic Energy Authority's chief engineer (inspection and progress) of the Industrial Group, works general manager at Dounreay and deputy director (personnel) of the Industrial Group, is to be the first chief inspector of nuclear installations.

The liability of the UKAEA is similar to that of other operators but without financial limit. The licensing provisions of the Bill do not extend to the Authority. The extraction of plutonium and other dangerous fissile materials is restricted by the Act to the Atomic Energy Authority and Government departments, who may, however, authorise other persons to extract these materials for research or development purposes only, subject to appropriate security controls. (See Atomic Review, 7 Nov. '58.)

International Nuclear Liability

Approaches aimed at achieving a solution of the international nuclear liability problem are the subject of a comprehensive report published by the Atomic Industrial Forum, the national association of the United States atomic industry. Entitled *International Problems of Financial Protection Against Nuclear Risk*, the report is based on a study conducted under the auspices of the Forum and the Harvard Law School by a Harvard research team. The Harvard study is the second major independent research effort on the liability problem that the forum has underwritten. The first, a study conducted for the forum by the Legislative Drafting Research Fund of Columbia University, was devoted to the domestic aspects of the problem. The report may be obtained through the forum at a price of $6 per copy. Requests may be addressed to Atomic Industrial Forum, 3 East 54th Street, New York 22, New York.

The problem to which the report is addressed arises, in the language of the report itself, " out of the risk, however slight, that damage of catastrophic proportions might occur abroad in the operation of atomic power facilities and related nuclear installations. This could impose a crushing loss both upon the public exposed to injury and also upon the enterprises operating or supplying the facilities, including American firms. The answer to the problem thus created involves devising means by which the risk of loss can be so allocated as to give reasonable protection to the exposed public while not obliging atomic enterprises to risk an intolerable burden of liability. . . . Ideally a solution is called for which would embrace *all* nations participating in the development of nuclear power, and which would deal with all phases of the third party liability problem." The report recognises that, as desirable as it might be, " a world-wide convention could not be negotiated until after many years of effort." The report notes, however, that, pending adoption of a global convention, a Western European convention now in preparation under the auspices of the Organisation for European Economic Co-operation could " serve on an interim basis as a partial groundwork for further international arrangements and national legislation." The report strongly recommends government indemnification for damages exceeding the limit for which operators and suppliers would be held liable under the draft OEEC convention, and urges that this be provided for in advance rather than after the event.

As to what the United States Government might be able to do to supplement the provisions of the OEEC convention, the report suggests three principal alternatives. The Congress could enact legislation to the effect that " recovery from a defendant in American courts for foreign nuclear accidents was not to exceed the amount to which recovery was limited under the law of the country in which the accident took place." Secondly the United States could become a limited participant in the regional convention, by accepting it with the reservation that it applied " in the United States only with respect to accidents occurring outside its territory." Thirdly, the United States Government, in the case of nuclear development programme requiring extensive United States assistance, such as the proposed Euratom programme, could seek " a hold-harmless undertaking for American suppliers, at least on a temporary basis." The report also recommends that consideration be given to another possible measure for the protection of the American supplier. It suggests that, by analogy to guarantees available under the Mutual Security Act, United States Government guarantees against nuclear liability arising out of foreign nuclear incidents should be made available to American suppliers for a fee. These guarantees would be to protect the supplier " against claims which are reduced to judgment against him in American courts. The guarantee would only be for the amount of such judgment in excess of the private insurance available for him."

OEEC Nuclear Liability

The steering committee of the OEEC European Nuclear Energy Agency, meeting on 18 June in Paris, agreed upon the ENEA draft convention on third party liability in the field of nuclear energy. The previously agreed provisions have been extended to cover nuclear accidents arising in the course of transport of nuclear fuels for which the same maximum liability has been specified.

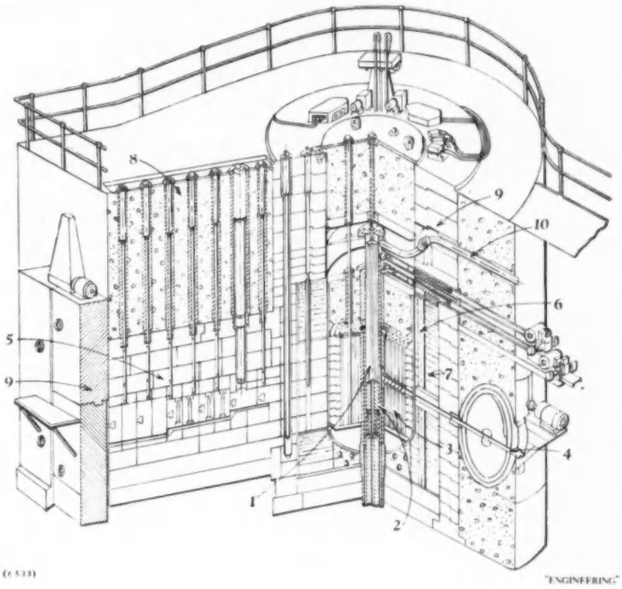


Fig. 2 Cut-away view of Soviet experimental fast reactor BR-2.

1. Core
2. Control rod shutoff absorbers
3. Reflector
4. Fast neutron beam hole
5. Thermal column (3 m)
6. Ionisation chamber shaft
7. Water shield
8. Concrete shielding
9. Iron shielding
10. Part of mercury circuit

Revised Health and Safety Organisation

A revised form of health and safety organisation has been introduced by the UKAEA. The principle that all Authority staff are responsible via the normal management chain of command for the safety of operations under their control remains unchanged and heads of establishments will continue to receive advice from their own specialist health and safety organisations. Separate health and safety organisations in each group headquarters are, however, being eliminated and a new Authority Health and Safety Branch is being established as part of the headquarters organisation of the Authority. Dr. A. S. McLean has been appointed to head the new branch with the title of director of health and safety.

Under Dr. McLean's direction, the technical work of the new Branch will be undertaken by two divisions:

A Safeguards Division, headed by Mr. F. R. Farmer and located at Risley, concerned with the safety of reactors, plant and laboratories; and

A Radiological Protection Division, headed by Dr. W. G. Marley, O.B.E., and located at Harwell. This Division will be concerned with all aspects of the health and safety of Authority employees and neighbouring populations, and will advise the safeguards division on the standards of human protection to be applied in the evaluation of the safety of nuclear installations. An administrative division is headed by Mr. I. G. K. Williams. The new arrangements took effect on 1 July, 1959.

Cost of Windscale Accident

The provisional estimate for the cost of the Windscale accident to Pile No. 1 is given in 1957-58 UKAEA balance sheet as £1,967,826. The write-off value of the pile is reported to be £1,500,000 and the figure for compensation to milk producers about £60,000. The net cost of operations for the year was £42,433,428 compared with £25,361,407 for 1956-57.

Reactor News

British Fast Reactor Team in Soviet Union

A group of four scientists from the UKAEA have recently been invited by the Academy of Science of the USSR to visit Moscow to see the 5 MW fast reactor, which has been operating for about a year. The party, which was led by Dr. R. Hurst, director of the Dounreay Experimental Reactor Establishment, were in Moscow from 8 to 13 July. At a later date a return visit by Russian scientists to see the fast reactor at Dounreay is likely to take place. A survey of fast reactor developments was published in Atomic Review last 13 March, when reference was made to the BR-5 plant. Details of the BN-50, the 50 MW fast power reactor which is to succeed the BR-5 were also given.

Soviet Fast Reactor BR-2

The evolutionary order of Soviet fast reactors is the BR-2, the BR-5, the BN-50 and the BN-250. A cut-away view of the first in the series, the mercury-cooled BR-2 is shown in Fig. 2. The drawing is taken from an abstract published in *Reactor Technology* (Journal of Nuclear Energy: Part B), vol. 1, No. 1, and originally appeared in *Atomnaya Energya* (A. I. Leipunski). Details of the reactor are tabulated below.

Data for Soviet Fast Reactor BR-2

Max. thermal power	100 kW
Max. fast neutron flux	10^{14}n per sq. cm per sec
Fuel	Pu
Fuel cladding, stainless steel (Each fuel element is hung on a tungsten shaft within a steel tube)	Spec. EYaIT
Reflector	depleted
Fuel rod, dia.	10 mm
length	130 mm
Fuel can, o.d.	10·8 mm
Number of fuel rods	108
Core size, right cylinder, dia.	130 mm
Reflector in two parts:	
Stationary part,	700 mm
height	700 mm
U-rod dia.	35 mm
cans	Stainless steel
Inner moving part	Ni-Cu alloy
Outer copper layer thickness	150 mm
Water tank layer thickness	500 mm
Cast iron layer	400 mm
Heavy concrete containing limonite	
Thickness	1,100 mm
Density	4·2 gm per cu. cm
Overall diameter of shield	5 m
Coolant	Mercury
Coolant volume fraction of core	17 per cent
Coolant flow rate	6 cu. m per hour
Temperature rise	30° C
Static temperature coeff. of reactivity	$-2 \times 10^{-5}\ \Delta k/°C$ (may become positive in certain circumstances)
Shut down heat removal capacity by natural convection	10 kW
Shield and control device cooling	Air
Heat removed from shield	25 kW
Air flow	6,000 cu. m per hour
Effectiveness of control devices:	
Compensating cylinder	0·033 Δk
Auxiliary compensator	0·0087 Δk
Automatic regulator	0·0016 Δk
Measured breeding ratio	2·1 ± 0·3

Dounreay Operating

Reports have been published that the fast breeder reactor at Dounreay has begun operating at low power. The reactor was originally due to start up in April, 1958. This month is now scheduled as the date for full operation.

MERLIN Critical: Unusual Features

The AEI research reactor MERLIN, which is shown in Fig. 3, went critical on 16 July. The 5 MW (thermal) tank reactor (originally designed for 1 MW but augmented owing to the shortage of experimental facilities in this country and abroad) has a number of unusual features. The core, which is arranged to move vertically, can take up four positions: a lower, storage position for non-operational periods; a top, charge-discharge, position; and two experimental positions, which enable an experiment to be set up in one while the other is being used. There is a 3 in thickness of water in the outer core-lattice row (instead of fuel elements), which ensures that there is no variation in reactivity between the two experimental core positions. There are no external plugs for the experimental holes: a lead door is rolled across and the tube filled with reactor water. A

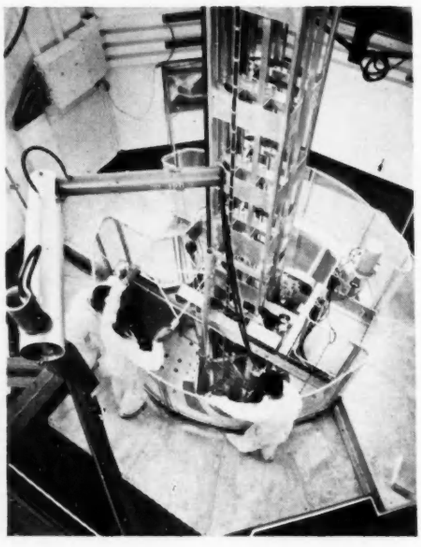


Fig. 3 A view into the tank of the AEI research reactor MERLIN, showing a fuel element being loaded into the core.

removable plug, in that it becomes irradiated, represents an additional hazard when withdrawn during operation. Neutron sources are fitted to each fuel element (over 90 per cent uranium 235) to give enhanced indication and control during startup and shutdown: rate of change of neutron multiplication during these operations can more readily be recorded if there are neutrons to multiply, and neutron sources of each fuel element ensure that they are present in sufficient quantities. The fast neutron flux is as high as that of any reactor in the country. There is no pressure shell: the safety of the reactor has been so thoroughly investigated and secured that permission has been given to dispense with a pressure-proof building. Safety has in fact been a prime consideration, and an unorthodox approach to this problem has been to enlist an Army brigadier and a major as safety officers and reactor operators. Being scientifically uncommitted, they will serve as a buffer between the over-enthusiastic research worker, who might be prepared to take risks, and the potentially dangerous instrument he uses.

Halden Reactor Critical

The boiling heavy water reactor of the Norwegian Institutt for Atomenergi at Halden, which is to be used for a joint programme of research and experiment organised by the OEEC European Nuclear Energy Agency, was successfully operated for the first time on 29 June. The reactor, moderated and cooled with heavy water and fuelled with natural uranium, is located in an excavation in a rock near the paper and pulp factory Saugbrugsforeningen in Halden, 120 km south of Oslo. It is the first boiling heavy water reactor in the world, and the first boiling water reactor in Europe. Besides its main function as a power demonstration reactor for studying problems associated with boiling heavy water reactor systems, the installation will also produce some 15 tons per hour of process steam in the secondary light-water circuit. Eventually this steam will be used in the paper factory and it is believed that this will be the first nuclear process steam installation. The reactor was designed at the Netherlands-Norwegian Joint Establishment for Nuclear Energy Research, Kjeller, and was built by the Norwegian Institutt for Atomenergi. The main sub-contractors were the Kvaerner-Myhren, -Thune Combine (mechanical installations), the Chr. Michelsens Institutt (control and instrumentation), Høyer Ellefsen (civil engineering work), the UK Atomic Energy Authority (fuel), and the US Atomic Energy Commission (heavy water). The total cost of the plant, including heavy water and the first uranium fuel load, was $3·5 million. During the next six months the reactor will be operated at low power levels to enable fundamental reactor physics experiments to be performed. After this period the power level will be increased gradually up to the design power of 10 MW thermal energy. The reactor plant will be officially opened on 10 October, 1959.

SRE Gives Superheated Steam

Superheated steam at 1,000° F has been generated by the Sodium Reactor Experiment (SRE) operated for the USAEC by Atomics International. The liquid sodium reached a temperature of 1,060° F.

Boiling Sulphur Reactor

The USAEC has selected, as a basis for contract negotiations, a proposal by Aerojet General Nucleonics, San Ramon, California, for the study of a new power reactor concept. The proposed reactor would be cooled by boiling sulphur at about 1,200° F (650° C). High thermal efficiency is theoretically attainable if the engineering problems can be solved. The nine-month study is to determine the practicality of this advanced concept.

Nuclear Superheat Development

Nuclear superheat studies are the subject of two contracts totalling $4·3 million recently awarded by the USAEC. One, awarded to Combustion Engineering-General Nuclear Engineering Corporation, concerns integral boiling superheated reactors and is of immediate importance for the reactor concept now being investigated by CE-GNEC under a subcontract with the Puerto Rico Water Resources Authority. The second contract, with General Electric, mainly refers to separate superheaters, though the work will also be of value in connection with integral superheaters.

Sodium-Heavy-Water Reactor Research Stops

The USAEC has suspended its research and development on a liquid sodium-cooled, heavy water-moderated nuclear power reactor concept. Work on the concept was started for the Commission in April, 1957, by the Nuclear Development Corporation of America. The work was undertaken in connection with the proposal of the Chugach Electric Association of Anchorage, Alaska, for construction of a 10 MW nuclear power reactor at Anchorage. In the two years since the research and development project was started, it became increasingly apparent that, technically, it would not be sound to build a reactor that was not yet proven at a remote non-Commission site. Consequently the Commission last February decided not to build a sodium heavy water reactor at Anchorage. The Commission's decision to end for an indefinite period research and development on the sodium heavy water concept was based on a technical and economic study of this concept by a task group of reactor engineers and physicists representing the Commission and Commission contractors. The group concluded that the technical feasibility of the concept is currently in doubt due to the many unresolved problems associated with the concept. Further, the group concluded that even if the technical problems were successfully solved, the cost of power produced by the system as at present understood would not be lower than that produced by other natural uranium power reactor systems. During the period in which research and development on the sodium heavy water concept is suspended, research and development will be continued separately on sodium technology and on heavy water technology as applied to other power reactor concepts. When these technologies have become sufficiently developed, the sodium heavy water concept will be re-evaluated to assess its technical feasibility and economic potential.

Advanced US Reactor Projects and Rejects

Besides the sodium-cooled heavy-water reactor, the USAEC has also discontinued work on LMFRE (liquid metal fuel reactor experiment). LAPRE-2 (Los Alamos power reactor experiment-2), a uranyl-phosphate fuelled reactor, is also being dismantled, having completed its work. A successor is not contemplated. LAMPRE-1 (Los Alamos molten plutonium reactor experiment-1) is almost completed and is due to run at full power in December. American plans for the 1960s' favour boiling-water, gas-cooled and organic-moderated reactors, according to *Nucleonics*.

Ships and Submarines

Vickers Steam Cooled Marine Reactor Advances

The marine reactor (see ENGINEERING, 15 May p. 638, 19 June p. 792 and 7 August p. 8) designed by Vickers Nuclear Engineering for the Admiralty gives 50,000 s.h.p. In a nuclear powered fleet aircraft carrier, damage control would suggest fitting four separate reactors, each normally supplying steam to one shaft but with cross connections. Four VNE reactors would be suitable in a sister ship to the Ark Royal, three of them being built to provide her full power of 150,000 s.h.p. The design could be simplified by fitting only one thermocompressor, one primary steam generator, and one secondary steam generator for each reactor. As no uptakes for combustion gas are needed there is great freedom in positioning the reactors fore and aft the ship. The carrier would have unlimited radius of action and an endurance at full power measured in years. At the request of the Galbraith Committee the VNE reactor project is now being scaled down for a tanker requiring only 20,000 s.h.p. The work is still in hand but it seems that the steam-cooled reactor may show up best on such small heat output with its moderator changed from heavy water to a mixture of lead and light water. This will reduce the size of the core and the shielding required and save both weight and space. The cost will be reduced by this and by saving the cost of the heavy water. Difficulties for the ship's company will also be lessened by not having to conserve expensive heavy water. This new variant of the VNE reactor may prove so small that it can be fitted in the small submarines (less than 1,000 tons) that NATO would like as anti-submarine submarines. Only one thermocompressor and primary steam generator need be used and the steam passed directly to the turbines at full power, a small secondary steam generator being included for use if a fuel element develops a leak. Thus, the system would be extremely compact and far more flexible operationally than the pressurised water reactors employed by the United States Navy. The advantage of unlimited submerged endurance at full power would be the same as in Nautilus.

English Electric Study Ship Reactors

The English Electric Company Limited have announced the completion of a preliminary survey of possible reactor systems for the economic nuclear propulsion of merchant ships. This study project has been carried out by a group of English Electric reactor engineers advised by marine engineers from Vickers-Armstrongs Limited, whose function was to deal with the marine engineering and shipbuilding side of the project. The group has been working for almost a year at Whetstone, the headquarters of the English Electric Atomic Power Division. This activity was initiated to explore the technical, operational and economic prospects for alternative forms of propulsion—both oil and nuclear—as applied to various kinds of ships. In the course of these studies the potentialities of a wide variety of reactor systems for commercial ship operation were examined, and a more detailed evaluation was made of one or two of the systems which showed commercial promise. An advanced gas cooled reactor, the organic moderated reactor, and the steam-cooled reactor are understood to be the systems most favoured. Further examination of the results of the study project should provide a basis for more detailed work in a narrower field as more information becomes available from sources within the English Electric Group and elsewhere. English Electric have an agreement with Atomics International of America in connection with organic-moderated ship reactors.

Skipjack Arrives

The United States nuclear submarine Skipjack arrived at Portland last week. The submarine, which has tear-drop hull form and a pressurised-water reactor more advanced than that in the Nautilus, is similar in design to the Dreadnought now building at Vickers' shipyard in Barrow.

Euratom to Study Nuclear Ships

The European Atomic Energy Community (Euratom) is proposing to push ahead with a thorough examination of the application of nuclear power for ships.

ANECHOIC CHAMBER FOR NOISE RESEARCH

By G. BERRY, B.Sc., A.M.I.Mech.E.,

National Engineering Laboratory

The noise of mechanisms is a subject that is demanding increased attention from managements in industry. Research into the subject requires special apparatus and techniques, one of the most important of which is the anechoic, or echo-free chamber. Recently, the National Engineering Laboratory, Glasgow, completed the construction of an anechoic chamber, described below, which is one of the best of its kind in Britain.

Design and Construction

It has become accepted that the most advantageous form of acoustic surface treatment is provided by fibreglass wedges arranged with adjacent dihedral angles at right angles. This acceptance derives from the work of Beranek and Sleeper[1], who published data showing a marked improvement over previous surface treatments and giving values for the sound-absorbing characteristics of various wedge-type structures. This data is not exhaustive in that it relates to an American fibre-glass with a density of 2·5 lb per cu. ft, and important differences may occur with fibreglass of different density and physical characteristics. In addition, the data was determined by an impedance tube method and as far as the author is aware, information is not available on the absorption

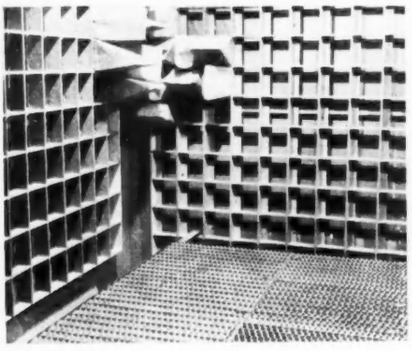


Fig. 1 Fibreglass wedges are fitted into the sockets, leaving a 2½ in gap between the wedge base and the wall.

characteristics of wedges when arranged on a surface.

Despite these limitations, use was made of the design information of Beranek and Sleeper in determining the size of wedges to be used to achieve a lower cut off frequency of 160 c/s. The wedges have an 8 in square base which continues in a parallel section for the first 3·5 in of the wedge length. The remaining 13 in consist of a taper to a screw driver edge, two of the flanks remaining parallel. The wedges are enclosed in muslin bags which assist in maintaining the geometrical shape and limit the quantity of dust falling from the wedges. The material of the wedge is 4·25 lb per cu. ft resin bonded fibreglass, this density being recommended by the suppliers from the aspect of self-sufficiency and lack of sag with time.

The manner in which the wedges are arranged may be seen in Fig. 1. The surfaces of the room were first covered by a 1 in thickness of Celotex boarding. A number of 3 in by 2 in wooden battens were then added and over these a series of 2 in by 1 in battens running in the transverse direction at 8 in spacing. On these light battens a honeycomb formed by ½ in Celotex boarding was built up which resulted in an array of 7·5 in square sockets.

The wedges were then inserted into the sockets to a depth which left an air space of 2·5 in between the base of the wedge and the Celotex board covering the walls. The wedges are held in position by the compression resulting from this insertion and no additional fixing has been found necessary.

This treatment was applied to the four walls, the ceiling and the floor of the room. The wall treatment was carried to the edges of the room as far as possible, the limit being provided by the encasements surrounding the structural framework of the building. The ceiling and floor treatments then provided a considerable overlap but fragments of untreated surface remained visible from the centre of the room, particularly in the corners. The remaining space was then filled by fibreglass of the same density in slab form. This was readily cut to fit around the structural encasements and was held in position by adhesive supplemented by a limited number of sheet metal straps in the case of material attached to the ceiling. The floor wedges were laid in a concrete pit, 2 ft in depth. A number of 4 in by 3 in channel columns support a free standing framework of 2 in by 2 in T-bars. On this framework is laid a light grille flooring in short sections which facilitate removal. Since the floor wedges were laid in a pit, the floor level is continuous at the door to the room.

Nine sky bolts, embedded in the ceiling and projecting 3 in below the level of the wedges, carry a system of light rails whereby a carriage carrying a microphone may be moved to any position in the room as the result of movements along two perpendicular axes. The coordinates of the carriage position are obtained from graduations on the rails.

The treatment of the walls is continued unbroken over the door which is carried on a tubular framework. Consideration was given to the manner of opening the door and it was decided that this tubular framework should be mounted on rails to allow the door to be withdrawn completely from the aperture. Any hinged system would necessitate undesirable deformation of the wedge arrangement to accommodate the swinging of the thick structure.

Cables to instruments in the adjoining antechamber are passed through tubes sunk into the wedges and passing through the intervening brickwork. A hole has been provided in the wall to allow a driving shaft to be connected between a motor outside the room and a mechanism within it. The hole is arranged to coincide with one space in the wedge honeycomb and it may be closed by stout covers when not in use. A section of the floor treatment is removable so that a fabricated stand may be bolted to the floor This stand is used as a mounting platform for the purposes of any investigation.

No provision has been made for ventilation of the room since operators are outside the room during measurements. In making preparations and adjustments within the room, the door may be left open and the natural air circulation is found adequate.

The internal dimensions of the bare room were approximately 13 ft 6 in by 13 ft by 12 ft in height, and the approximate dimensions of the finished room (Fig. 2) are 10 ft 6 in by 9 ft 6 in by 8 ft.

Testing the Chamber

A chamber is said to be anechoic if a sound field can be established within it without objectionable interference from sound reflections at the boundaries.

The most satisfactory method of assessing the amount of these boundary reflections consists of

Fig. 2 The finished chamber measures about 10½ ft by 9 ft by 8 ft and has a removable floor grill.

measuring the sound pressure in the chamber as a function of distance from a source. A point source in free space will excite a spherical sound field in which the sound pressure varies inversely as the distance from the source. A commonly quoted criterion is that deviations from this law should not exceed ± 1·0 dB.

A practical limit to the accuracy of the inverse distance law method of determining the degree of boundary reflection is provided by the source and the receiver which are employed. The source should be small so that its dimensions are small compared with the wavelength of the sound being radiated. The microphone should be such that its insertion into the sound field does not significantly affect the field at the point of measurement. In addition, the power of the source and the sensitivity of the receiver must be sufficiently great that the output from the receiver is well above the electrical noise level at the input stage of the measuring amplifier. To determine absolutely the properties of the room, a number of sources and receivers for different frequency ranges is desirable. It was not considered that the expense and time involved on such elaboration was warranted since the object of the investigation was to establish the adequacy of the room for its intended purpose. A fairly simple source and receiver were devised which were considered entirely adequate at lower and middle frequencies but which could be regarded as second rate at high frequencies. At these high frequencies it is possible that some of the observed irregularities are due to the source and receiver.

The source used consisted of a horn driving unit to which was coupled a tube 10 in in length with a bore of 0·25 in. The body of the unit was screened by a 2 in thickness of fibreglass to minimize reflections from its surface. The source was suspended from overhead rails in the centre of the room since this is the position in which mechanisms will normally be tested.

The receiver consisted of a condenser microphone inserted into a cylindrical jacket to which

was coupled a tube of 0·25 in bore and of 30 in length. The receiver was suspended from a movable carriage with the axis of the probe tube at right angles to the radial line along which observations were taken.

Measurements were made along a horizontal line parallel to one wall of the room at frequency intervals of $\frac{1}{3}$ octave from 100 c/s to 8,000 c/s with the floor grilles in position. The measurements were made at unit intervals of 0·5 in to a distance of 50 in. A second series at frequency intervals of 1 octave from 125 c/s to 8,000 c/s was made with the floor grilles removed. The line parallel to a wall was selected since the principal axes of the mechanisms to be investigated will inevitably lie in this direction as a result of the need to provide a drive from the adjoining room. In consequence, measurements will commonly be made along such lines. Smaller deviations would be expected from measurements along a room diagonal, in view of the more complex reflection pattern required to establish standing wave effects. It was felt, however, that such a course would be unrealistic in view of the room's projected use. Similarly, particular importance is attached to the measurements taken with the floor grilles in position since, in practice, it would prove highly inconvenient to remove these grilles after each adjustment.

Assessment of Results

In Fig. 3 the measured values of rms sound pressure level are plotted against distance from the source for the series of observations in which the floor grilles were removed. Distance is plotted on a logarithmic scale so that the theoretical inverse distance law relationship may be plotted as a straight line falling by 20 dB as the distance is increased by a factor of 10 : 1.

The deviations from the inverse distance law derived in this way are shown in Fig. 4 for the series of measurements with the floor grilles in position, and for that with the floor grilles removed. The results at 800 c/s, 1,000 c/s, and 1,600 c/s require special consideration and the remaining frequencies will be discussed first.

For these frequencies the deviations at 100 c/s and 125 c/s are in excess of the criterion of $\pm$ 1·0 dB but from 160 c/s to 4,000 c/s the deviations up to a distance of 75 units are within the limits $\pm$ 1·0 dB. This applies whether the floor grilles are in position or not and indeed their removal has little influence at frequencies below 2,000 c/s. At frequencies above 4,000 c/s the deviations become appreciably larger and it is necessary to remove the floor grilles at 8,000 c/s if the deviations are to fall within $\pm$ 1·0 dB at distances up to 75 units, i.e. 37·5 in.

The results at 800 c/s, 1,000 c/s, and 1,600 c/s are quite out of keeping with the other frequencies The behaviour over the first part of the radial line is normal, but as the wall is approached, the deviations are unduly large. It was first thought that this might be due to the effect of the floor grilles, but it will be seen that at 1,000 c/s their removal had an effect little more than that which could be attributed to experimental error. It was next considered that the effect might be due to the overhead rails or to the T-bars which provide the grille support. The disposition of the rails was altered considerably and the axis of measurement was turned through 90° parallel to the adjacent wall so that the relationship of the T-bars to the axis of measurement was completely changed. This again had no significant effect. Finally, the source and receiver were replaced by a moving coil microphone of the ball and biscuit type and the observations repeated. The effect of this modification was to increase the extent of the deviations by 25 per cent, but not to modify the characteristic shape of the curves.

It was concluded that the deviations must be attributed to some permanent feature of the room and that the wall treatment itself is the probable source. It is of interest that the wedge spacing is 8 in and the dimensions of the honeycomb is 7·5 in. The frequency of sound with a wavelength of 8 in is 1,680 c/s and of that with a wavelength of 7·5 in is 1,790 c/s approximately at room temperature. It is probable that there is a significant connection between these dimensions and the frequencies at which the disturbances occur, and that the increased divergencies are due to the regularity of the wedge array.

Despite these effects, the total range of the deviations up to a distance of 75 units is 1·6 dB at 800 c/s, 2·2 dB at 1,000 c/s, and 2·8 dB at 1,600 c/s.

The deviations at 1,000 c/s and 1,600 c/s are in excess of the criterion $\pm$ 1·0 dB, but are not sufficiently large to prove troublesome in the examination of engineering noise sources. For the calibration of microphones, however, the range of measurement at these two frequencies should be limited to the region free from large irregularity.

If an anechoic chamber is intended for work down to the threshold of hearing, it is advisable to arrange that the structural walls of the chamber are isolated from the main building structure. This appears to be an unnecessary refinement where the chamber is intended for the investigation of noise problems.

Table I gives values for the mean rms sound pressure level measured within the room and arising from high speed, heavily loaded machines located in a laboratory some 60 ft away.

Fig. 3 (right) Sound pressure level and distance from source with floor grille removed.

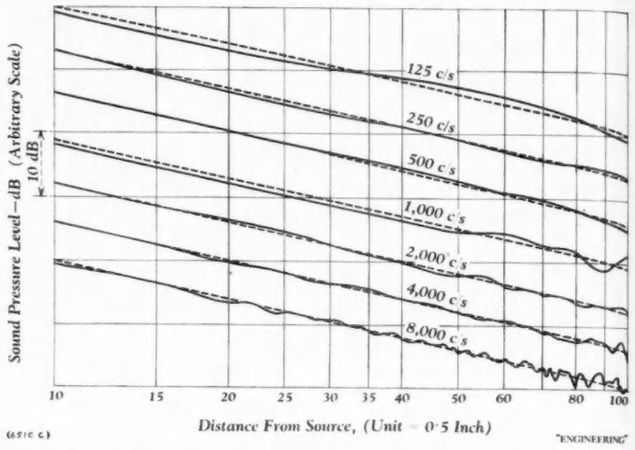


Fig. 4 (below) Deviations from inverse square law.

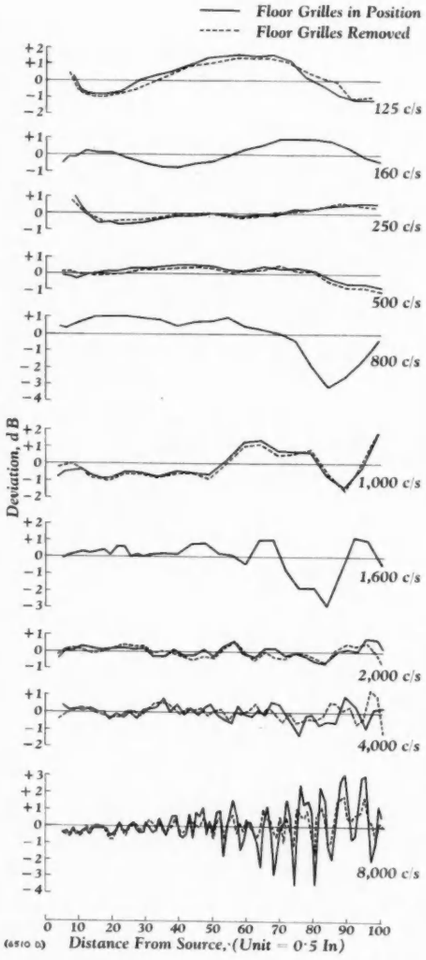


TABLE I

Mid band frequency, c/s	Mean rms sound pressure level (dB > 0·0002 dyn/sq. cm)
40	27
50	34
64	22
80	20
100	19
125	17
160	24
200	11
250 to 16,000	<0

These levels are, in fact, below the threshold of audibility. The closing of office doors represented a problem in that impulsive waves were transmitted through the building, producing kicks in the sound pressure level considerably in excess of these values. The problem was limited by adding pneumatic buffers to the doors so that sudden fluctuations did not exceed 10 dB of meter readings.

Conclusions

(1) The chamber provides an environment entirely satisfactory for the investigation of noise in mechanisms. (2) The deviations from the inverse distance law for sound radiation are within $\pm$ 1·0 dB for distances up to 3 ft and at frequencies from 160 c/s to 8,000 c/s when the floor grilles are removed. With the floor grilles in position, this upper limit becomes 4,000 c/s. (3) Exceptions to this statement occur at 1,000 c/s and 1,600 c/s when the total deviation becomes 2·2 dB and 2·8 dB respectively over the distance specified. (4) At 800 c/s, 1,000 c/s, and 1,600c/s, unduly large deviations occur which are attributed to the regularity of the wedges in the surface treatment. (5) The ambient level in the room under normal working conditions is down to the threshold of hearing.

Acknowledgements: The work was carried out in the Mechanisms, Metrology and Noise Control Division of the National Engineering Laboratory, East Kilbride, Glasgow, as part of the research programme of the National Engineering Laboratory Steering Committee. It is published by permission of the director.

REFERENCE

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FOCUS FOR RESEARCH AT WARREN SPRING

Laboratory Where Many Programmes Intersect

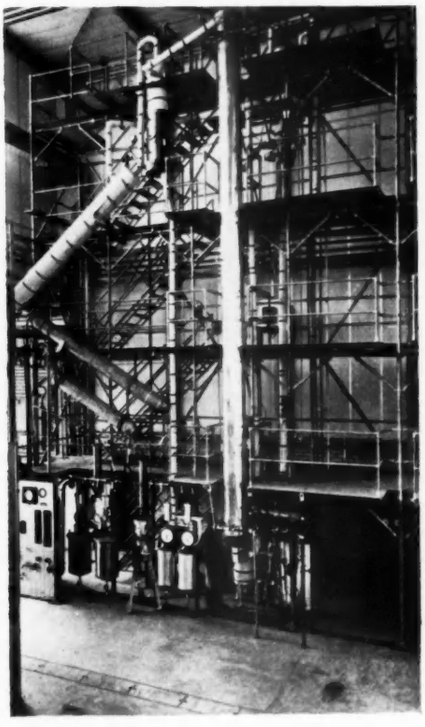
"During the last eight to ten months we have been engaged in discussing with industry what they want. We are trying to provide a national service that is wanted—we are not trying to foist it on anybody." Mr. S. H. Clarke, Director of the new Warren Spring Laboratory at Stevenage, was discussing the laboratory's future programme. "There is a need for certain kinds of basic information; and although a university does obtain basic information, you must have somewhere where you can have 'conditioned' research. The new laboratory should provide a focal point between industry, the universities, the research associations, and others. It is an attempt to provide a national expression of the cooperation between industry and the Department of Scientific and Industrial Research."

Warren Spring Laboratory gets its title from a lane that used to run across the site. In this way the station is not committed by name to any restricted field of activity. The Research Council of DSIR envisaged it as able "to carry out process research and development over a wide field not limited to particular areas of technology." At the same time the Fuel Research Station at Greenwich was closing down and the staff there were available for the new laboratory, ready to take up work on different programmes. Only two FRS programmes were transferred to Stevenage: abatement of air pollution and synthesis of chemicals by the Fischer-Tropsch process.

However, these were not the sole datum points about which the laboratory could be designed. There had been an indication of the need for work on a pilot scale in various fields, the Fischer-Tropsch process being only one example; and a need had been recognised for research into mineral processing. Also the work on chemical engineering carried out at the National Chemical Laboratory was to be transferred to Warren Spring Laboratory. With these considerations in mind, the Department decided to build a laboratory in the modern industrial style. It was to be as flexible as possible in interior layout, to initially house staff about equal to that of the Fuel Research Station, and to have facilities for both laboratory and pilot-scale work.

Warren Spring Laboratory is able to carry out process research and development over a wide field.

Within the pilot-scale laboratories large items of equipment can be housed, such as this Fischer-Tropsch pilot plant.



BUILDING FOR EXPANSION

A general view of the buildings is shown above. The main three-storey building (on the right of the illustration) is 372 ft long and 37 ft 6 in wide. It runs approximately east-west, fronting a future link road between Gunnels Wood Road—the present road to the laboratory—and the proposed new trunk road (A1) passing the western boundary of the site. The construction is based on a 4 ft module—expressed elevationally by vertical posts supporting floors and roof, and internally by posts placed centrally along the length. Only the spine corridor and secondary staircases have solid walls, all other partitioning is of light demountable prefabricated construction.

This spine corridor is set to one side of the central supports. Its eccentricity gives a laboratory width of 18 ft on one side and 13 ft on the other. To make full use of the flexibility offered by demountable partitions, the laboratory benches themselves are readily adjustable in position, and service connections (gas, water, compressed air, electricity) are available at every 3rd module (12 ft) along the perimeter. The fume cupboards installed (there is room for more if required) are arranged along the inner fixed corridor wall and the vertical extractor or duct from each discharges into an individual honeycomb brick enclosure on the roof.

At right angles to the laboratory building runs a three-storey administration block. It is built in much the same way as the laboratory block, the chief differences being the lower ceiling height and the use of wooden window frames for the ground-floor library. Also in this block are a conference room, director's suite, registry, and clerical offices.

There are three pilot-scale laboratories behind the administration block, arranged as wings to the main laboratory and connected to it by corridors. They comprise large enclosures capable of dealing with a wide variety of research (standing in pairs back-to-back for economy—but only one half of the laboratory intended for mineral processing has been built at present). Each unit consists of a main hall, 90 ft by 35 ft by 37 ft 6 in high, in which large equipment can be erected. Lower bays flank the halls and large folding doors allow heavy plant to be easily moved in and out of the buildings. The structure is carried by precast concrete posts, which also carry the travelling-gantry rails. In the mineral processing building a 4 ton lift is installed to take skips and trucks containing mineral ore from ground floor to gallery. Small laboratory units stand on either side of the corridors leading to the main block.

A large steel-framed building comprising six east-light bays, each 60 ft by 30 ft minimum head room, house workshops and engineering stores. Nearby are boiler house, gas producing

plant, electrical substation, and garages. The low building on the left of the illustration is the canteen.

All buildings are capable of up to 100 per cent expansion laterally. In addition the main and pilot scale laboratories could be duplicated south of the workshop group.

FACILITIES WITH CENTRAL SERVICE

One of the main divisions of the laboratory provides a comprehensive central service of analysis (chemical and physical), instrument development, physical measurement (temperature, electrical quantities, gas volume, rate, density, etc.) and photography. It is unusual to place all these services under a main division, but this was selected as the best way to obtain integration. The Physical and Chemical Services Division, as it is called, has a staff of about 50 and, basically, it assists other divisions in their more routine functions. Special equipment includes gas chromatography, quartz and infra-red spectrometers, and equipment for X-ray diffraction and fluorescence spectrometry.

The design and construction of plant for laboratory and pilot-scale projects is undertaken by the Engineering Services Division. This has a drawing office and an industrial staff of about 120, and the workshops mentioned above.

The Intelligence Division provides library and editorial services and is also setting out to provide an information and project appraisal service. A start has been made, for example, in building up a centre of information on mineral processing. Such information is valuable in deciding the worth-whileness of practical investigations before they are implemented.

Engineering services and plant installed at Warren Spring Laboratory are as follows.

Steam.—Used by the laboratory for process work, especially in production of gas for the Fischer-Tropsch process. Two John Thompson boilers of the super-economic type operate at 120 lb per sq. in, providing 10,000 and 5,000 lb of steam per hour. They burn heavy grade fuel oil (3,000 secs Redwood Scale No. 1).

Gas Plant.—Provided for the generation of blue water gas and the catalytic cracking of butane. Gas for use in the Fischer-Tropsch process is produced at a rate of 4,500 std cu. ft per hour in a conventional water-gas generator. There are arrangements for feeding carbon dioxide with the steam so as to vary the hydrogen/carbon monoxide ratio between 1·15 and 0·6. The gas is purified from hydrogen sulphide in Gastechnik towers and washed with caustic soda to control the carbon dioxide content. It is then raised to 15 atmospheres in the first two stages of a four-stage compressor, passed through active carbon scrubbers to remove organic sulphur compounds, and further compressed to 120 atmospheres. Humphreys and Glasgow Limited designed and erected the gas plant.

Electricity.—The estimated demand of the laboratory in its present state is 500 kVA, but the electrical substation has been designed to allow for an increase in capacity up to 1,500 kVA. The incoming main is 11 kV, 50 c/s, 3-phase, and is transformed to 415 and 240 V. The Eastern Electricity Board have arranged the substation as part of their ring main. Thus an alternative supply to the site can be provided should a cable breakdown or similar emergency occur. A 100 kW mercury arc rectifier provides direct current at 220 V.

Compressed Air.—Two air compressors working at 100 lb per sq. in supply the laboratories and the industrial processes. The same supply of air is used for pressurising the electrical installations in hazardous areas (around the Fischer-Tropsch pilot plant, for example).

Town Gas.—A supply of high pressure town gas from the Eastern Gas Board is taken to a meter house, where a governor and low pressure type meter is installed. Gas is supplied to all buildings, with provision for heavy demands in pilot-scale laboratories.

Water.—An essential requirement was that a 24-hour supply of water, of guaranteed quantity and pressure, should be available as a precaution against failure of the main supply during continuous running experiments. The requirement is met by a high level reservoir in reinforced concrete, the supporting structure being designed integrally with the flues from the boiler house. It can be seen in the illustration.

Service mains are distributed over the site in open splay-sided trenches.

PROCESS DEVELOPMENT

The Fuel Research Station's study of the synthesis of oils and chemicals from carbon monoxide and hydrogen are being continued at the request of the Ministry of Power. It forms part of a project to develop, if possible, an economic way of producing oil from coal; but it also bears importance in so far as it throws light on the development involved between discovery of a reaction and building commercial plant.

Producing oils from coal is a two-stage process. In the first stage the coal is completely gasified to yield carbon monoxide and hydrogen; in the second the gas mixture is catalytically converted into the desired end products. Only the second stage concerns Warren Spring Laboratory.

From the economic point of view, the most promising version of the Fischer-Tropsch process for use under British conditions is that known as the slurry process. The present programme is aimed at improving this process and obtaining the data necessary for the design of a full-scale reaction vessel. The experimental reaction vessel, shown in the illustration, has a diameter of 10 in.

MINERALS AND CHEMICALS

The increasing use of unfamiliar metals by the atomic, aircraft, and electronics industries—to mention a few—has led to the recognition that much information is needed about methods of processing the ores of such metals. The chemical processing of uranium ores, for example, has been studied at Harwell. This work has now been transferred to Warren Spring Laboratory as part of the overall programme there.

It seems probable that for some time a fair proportion of the effort of the Mineral Processing Division will be engaged on sponsored work on particular ores, but it is hoped to include basic investigations, such as the study of grinding in the presence of additives like surface active agents, the kinetics of bubble attachments to mineral surfaces, a study of the behaviour of mineral particles in high tension fields, and the modification of this behaviour by various surface treatments.

The laboratories are equipped to handle most laboratory-scale mineral dressing operations such as flotation, jigging, tabling, heavy-media separation, wet and dry magnetic separation, and high-voltage separation. In the hydrometallurgical field, facilities are available for atmospheric and pressure leaching, for fluidised bed roasting, chlorine metallurgy, and solvent extraction. Pilot plant facilities enable crushing operations to be carried out at up to 2½ tons per hour, and flotation plant is available for treating up to 1,000 lb per hour. Full-scale tests using radioactive tracers can be carried out.

The need for a central organisation to undertake research on chemical engineering has been much discussed in recent years. The Chemical Engineering Division at Stevenage recognises itself as having three functions:

1. To carry out research on physical operations which play an important part both in processes that are under development at the Laboratory and in more general use in industry.

2. To undertake research sponsored by industry or Government departments.

3. As a result of these functions to accumulate basic information on chemical engineering for use by others.

Because of work going on elsewhere in the DSIR on heat transfer and fluid flow, it is proposed to concentrate on the field of mass-transfer, and in particular to obtain data permitting more accurate prediction of the performance of gas-liquid contacting equipment—for the design of distillation columns, gas absorption towers, and reactors of the liquid phase type.

ATMOSPHERIC POLLUTION

The work continues that began at the Fuel Research Station. It is designed to meet the requirements of the Ministry of Housing and Local Government and includes abatement of pollution, study of pollutant chemistry, development of measuring instruments, and the study of pollution distribution.

The present programme shows the wide field of choice that is before the laboratory. In addition to the factors that influence the work of other DSIR laboratories there is the greater amount of sponsored work that is to be done. In Mr. Clarke's view: "If the work is to become, and remain, coherent and increasingly effective as the years go by, it will be extremely important to exercise wise judgment in the choice of programmes at this stage, to ensure that the programmes tend towards the deepening as well as the widening of the experience of the teams engaged in research, so that they acquire knowledge and experience in fields that are of wide application."

LONG-LIFE RELAY

Using New Electrochemical Principle

A new development in electric switches, having considerable potentialities, has recently been announced by the Ovitron Corporation, Detroit, USA. It will do the same job as an ordinary electromechanical relay but with no moving parts, and therefore possesses a much greater life expectancy.

The relay is based on an electrochemical phenomenon that has only recently been observed, according to its inventor, S. R. Ovshinsky. Tantalum electrodes placed in a certain type of electrolyte will only conduct alternating current if a third (platinum) electrode in the solution is positively charged. The charge required is only about two volts, and removing the charge almost immediately returns the main electrodes to their non-conducting state.

Early samples of the device have been made in the form of miniature plug-in relays rated at 70 volts peak, and 4 amp. The electrolyte and electrodes are sealed into an epoxy plastics container, to prevent evaporation of the solution. Gases liberated during operation pass through a gas permeable, liquid tight, diaphragm, to be condensed and then returned to the solution.

The operating temperature range is from 15° F to 300° F and it is claimed that the unit is insensitive to shock and vibration. It will withstand a peak surge overload of up to 140 volts, whereupon it may short circuit to become a permanently closed switch.

The principle on which the relay works is not yet fully understood. It is believed that when the two main electrodes are immersed in the electrolyte they become covered with a thin insulating oxide layer. Under these conditions only a very small leakage current will flow. However, when the "grid" electrode is made sufficiently positive, the insulating properties of the oxide film appear to be broken down, only to return again when the positive charge is removed.

On the Shelf

By Frank H. Smith

I am not, normally, a very methodical person, and the only time I try anything like a "system" is when it encourages my natural laziness. Thus, to save hanging on to a telephone line longer than necessary I keep a little card index of regular telephone numbers with a special note of extensions. This may sound quite usual to you except that most people keep an alphabetical telephone book. The reason mine is a card index is because I have regular contact with two Ministries and if I were to keep a book it would not last a week. If any Ministry manages to keep its departments on the same extension for more than a month it is evidence of the fact that the age of miracles is not past. No, they prefer to put you through to some anonymous department called inquiries who thumb through a ministry directory, give you the extension (which will be different next time) and then "flash" the switchboard to have you transferred.

Incidentally, an advantage of the card index over the book is that GPO "change of number" cards are 5 × 3 and they can be bunged in as they come through.

Those librarians who have time not only to keep tabs on the subject in which their library deals but also to keep abreast of trends in library witch-doctory will like to know of two new Pergamons. There is a symposium *Modern Trends in Documentation* (held in Southern California) at 35*s* for 112 pages, and a quarterly (for the rates to which you will have to send to Pergamon) called *Problems in Information Storage and Retrieval*. I suspect that the storage bit does not refer to elastic shelving so much as holes with cards round them. Pergamon have in view *The Technique of Abstracting* and if I say this is to be by J. Farradane it will be enough for those in the know.

University Microfilms (who microfilm ENGINEERING), who were in New Bond Street, have moved to 44 Great Queen Street, London, WC2. Their number is now HOLborn 0808.

The Institution of Mechanical Engineers contrived to bring out the first number of the new *Journal of Mechanical Engineering Science* during the printing stoppage. This is to be a quarterly at £3 a year or £1 a copy. Its object is to "provide an avenue of publication for papers and articles of a fundamental and scientific nature." It will be nice to have a new avenue.

In November, Pergamon contemplate publication of an *International Journal of Heat and Mass Transfer*. As is usual with these Pergamon journals there is an honorary editorial advisory board a mile long, headed by co-chairman E. R. G. Eckert of the University of Minnesota and O. A. Saunders of Imperial College. Contributions are invited and rules for contributors are obtainable from Pergamon.

In this commentary business, one is made to realise quite forcibly how rapidly time flies. It seems only yesterday that I drew attention to the ASME annual review of heat transfer literature for 1957 and now the 1958 review has appeared in *Mechanical Engineering* for July. With the interest of aerodynamicists in supersonic and hypersonic speeds, more and more aeronautical journals appear in the bibliography, which is divided into some 15 spheres of interest. And talking of heat, a new aspect of it was presented to me the other day when I was asked for any information on the use of refractories for the surfacing of ICBM take-off platforms. Anybody know?

The University of Illinois Engineering Experiment Station (49 Administration Building (West), Urbana, Illinois) now produces an annual "Summary of Engineering Research," the first covering 1957-58. It reviews the work done, the people who do it and the publications which result.

BEGINNER'S LUCK

Physics is Easy. By D. S. WATT. *Princes Press Limited, 147 Victoria Street, Westminster, London, SW1.* (63*s*)

When a reviewer in a technical journal is faced with an introduction to the elements of a science, he has an excuse for putting his emphasis on style and presentation rather than on content. And Mr. Watt's object is to teach elementary physics to those whose only equipment is some knowledge (perhaps derived from his earlier book *Mathematics is Easy*) of mathematics.

Scientists have acquired a reputation for using a mysterious and exclusive jargon. Consequently when a scientist writes for laymen he has to overcome a resistance to communication, and lure his reader into the field of scientific thought. To this end a popular gambit is the use of chapter headings by Lewis Carroll. More austere expositors fill their text with variations of type, paragraph indentations and summaries. Others, mainly mathematicians and astronomers of philosophical bent, exert an insidious appeal with lucid and elegant prose. Mr. Watt does not fit any of these models. His approach (in the American phrase) is personalised: he flatters, bullies and cajoles: "Are you bored with all this? Cheer up . . . Take a rest if you are tired . . . Keep at it please. It will pay you in the long run." In spite of the teacher's insight in this kind of thing, the tone is likely to repel as many readers as it consoles.

In contrast, there are many passages of lucid and serious scientific exposition. Yet the consequent fluctuation of tone results in some confusing grammar. "Now do work on the gas by it being, say, pressed back by a piston from C to D . . . In so doing, work is done on the gas, equal to DCKF."

". . . the temperature range is T_1-T_0 and the heat used in doing work, as it could be in expanding, would be T_1-T_0."

"If you have a coffee in the dark and crunch a lump of sugar, flashes of light will result."

A merit, though obscured, of Mr. Watt's book in his emphasis on definitions and basic methods of argument. In particular the chapters on mechanics, which take up 200 of the book's 560 pages, gain from the repetition or reformulation of meanings and calculations. However, as the book becomes more concerned with the concrete aspects of physics (and Mr. Watt deals with hydrodynamics, heat, wave motion, optics, magnetism, electricity and the atom, among other things) an almost insuperable problem arises. It is experiment that gives physical "facts" reality, and application that gives them significance. Naive references to history (Archimedes "had tremendous mental powers. Study him and you will love him") and illustrations of turbo generator sets are inadequate substitutes.

The moral of both Mr. Watt's strengths and his weaknesses is that the written word commands more concentrated attention than the spoken word, and that in expository writing there is no substitute for a tone as far as possible consistent, and implying an intelligent appeal to intelligence.

Physics is Easy is divided into 95 chapters and a good index. It is clearly printed and there are 122 excellent diagrams. A few unfortunate misprints involving symbols have crept in, the binding is poor, and the price exorbitant.

JOBS FOR THE BOYS

Basic Electronics. By PAUL B. ZBAR and SID SCHILDKRAUT. Second Edition. *McGraw-Hill Book Company Incorporated, 330 West 42nd Street, New York 36, NY, USA* ($2·25); and *McGraw-Hill Publishing Company Limited, 95 Farringdon Street, London, EC4.* (17*s* 6*d*)

The manual is one of five written under the guidance of the educational advisory committee of the Electronic Industries Association of the United States. It is intended to supply schools with an integrated and standardised programme for training technicians to industry's need. Second editions of three of the series, including this one, have been produced to take account of the increasing use of transistors.

There are 31 "jobs" set out in the manual, and they include not only basic electronic experiments such as "the diode rectifier" but also exercises to familiarise the student with tube testing equipment and with basic components such as power transformers, loudspeakers, and so on. Nine of the jobs are concerned with transistors. The ready availability of American valve types in Britain makes many of the experiments requiring them easy to carry out in laboratories here. The position is, however, different as far as transistors are concerned. Since the manual is intended to be followed step by step, it would have to be partially rewritten if laboratories are to use British transistors. The departure from British Standards as far as symbols and circuit diagrams are concerned is not so serious, as it is likely that technicians will need to be acquainted with American usage.

The jobs are very clearly written, but are intended for use with classroom instruction: for example, reading this manual alone would not enable the student to answer the questions it sets out at the end of each job, and no bibliography or index is given. Instructors' guides are however, available. The manual is a valuable contribution by the United States electronics industry to the task of training its technicians.

DIESEL ROCK AND ROLL

A Handbook on Torsional Vibration. Compiled by E. J. NESTORIDES. Published for *British Internal Combustion Engine Research Association* by *Cambridge University Press, Bentley House, 200, Euston Road, London, NW1.* (110*s*)

A Handbook on Torsional Vibration, compiled by Mr. E. J. Nestorides of the British Internal Combustion Engine Research Association, reviews practically all the important work done on torsional vibration over the years with special reference to diesel engines and their drives. Copious references, extracts from the original papers and summaries, are given and as far as possible, an attempt has been made to fill some of the gaps in the information by tests carried out at the research laboratories of BICERA, and by experimental data from the member firms. From this standpoint, therefore, the book is most valuable and the results should apply to the range of diesel engines made by the member firms.

Most of the work and methods given are well known and established and can be used with confidence. The experienced vibration specialist, however, will examine the book in the light of the classic work of Dr. W. Ker Wilson—*Practical Solution of Torsional Vibration Problems*, which is equally well supported by experiment and experience. Indeed, the latter book has a wider application because of that author's experience in the marine and aero-engine field.

The book has been methodically planned as it follows through the processes and determination of data required for a full torsional vibration

analysis. Thus the first part deals with preliminary calculations and measurements of moments of inertia and stiffness, leading to the natural frequencies. The second part treats the evaluation and prediction of torsional vibration stresses, including vibration measurement and estimation of damping. The rules and recommendations of the Classification Societies regarding permissible torsional vibration stresses are given, which enables a design to be evaluated. Part three considers the design and operation of various devices for limiting vibration, while part four of the book reviews the instrumentation available.

Much attention has rightly been given to the equivalent stiffness of the various types of engine crankshafts, and a useful collection of previous work is given, together with BICERA's review and recommendations. This is most useful. The torsional characteristics of a wide variety of couplings and clutches are given, including the effect of non-linearity. Examples of couplings using rubber materials are given in much detail, but the Bibby coupling is discussed briefly, although much more is known on its behaviour. Brief mention is made of a coupling which is most popular on the Continent, and which has proved very useful in reducing resonant peaks. This coupling has a slotted cylindrical sleeve pack of springs fitted between the primary and secondary part of the coupling.

Reference is made in one figure to the Metastream metal disc-type coupling, without any indication of its value in torsional oscillation. This coupling is torsionally stiff but gives axial and bending flexibility. A little information is given on fluid and electromagnetic couplings. This is surprising in a book dealing with diesel engines, because such couplings are used in geared diesel drives.

As regards the calculation of natural frequencies, the well known methods are given in fair detail and in a manner which will prove extremely useful. The effective inertia method, so ably dealt with in W. Ker Wilson's *Practical Solution of Torsional Vibration Problems*, is included as one of the most important methods of examining complicated systems.

No mention is made of the use of digital computers for such analysis. This is now standard where computing machines are available and it ought to have been mentioned in a book such as this as it takes the labour out of the calculation and permits changes to be examined with ease.

The exciting forces arising in diesel engines are given in detail in the usual standard form, together with schedules for harmonic analysis of the torque diagrams. The combination of the torques, due to individual cylinders and their vector sums, are completely described, together with discussions on the effect of firing arrangement. The part dealing with dampers and detuners will prove useful, as will the description of various equipment for the measurement of vibration amplitudes.

The book will definitely be of value to both the research and the practising engineer, and to the student.

DATUM IN SPACE

High Altitude and Satellite Rockets. A Symposium held at Cranfield, 18-20 July, 1957, *Royal Aeronautical Society, 4 Hamilton Place. London, W1*, and *British Interplanetary Society 12 Bessborough Gardens, London, SW1.* (32*s* 6*d*)

The idea of holding a symposium on high altitude and satellite rockets in this country was conceived by the College of Aeronautics and it was a sign of the times, even before artificial satellites were successfully placed in orbit, that both the Royal Aeronautical Society and the British Interplanetary Society were asked to participate in the organisation on an equal footing. The symposium was held shortly before the first satellite was launched, and was attended by nearly 200 people, largely from British industry and official circles, but also from the USA and various European countries including Poland and the USSR. Though much of what was disclosed on that occasion must by now have been superseded, the publication of the proceedings is an event of historical importance and a datum for what has happened since.

In addition to a series of a dozen papers a number of demonstrations of rockets and ramjets were arranged. The very wide coverage of the conference can be seen from the list of titles: The Scientific Applications of Rockets and Satellites (Massey), The Satellite Launching Vehicle (Rosen), British Upper Atmosphere Sounding Rocket (Stephens), Some Propulsion Problems of High Altitude Rockets (Baxter), Design Problems of Large Rockets (Bossart), USSR Rocket and Earth Satellite Programme for the IGY, Recovery after Reentry by the Use of Aerodynamic Lift (Hilton), Dynamics of a Dissociating Gas: Non-Equilibrium Theory (Freeman), High Temperature Materials in Relation to the Satellite Reentry Problem (Murray), Some Problems of Instrumentation, Telemetry and Guidance (Lines), Problems of Respiratory Metabolism in Sealed Cabins (Clamann), Psychophysiological Hazards of Satellite Flight (Henry), and Future Developments in Rocket Propulsion Beyond the Atmosphere (Shepherd).

The great majority of the papers are non-mathematical in character and give a good general coverage of some fairly broad problems or areas of interest. The only exception is the paper Dynamics of a Dissociating Gas which is a highly mathematical treatise on a problem of comparatively limited interest and is not in keeping with the rest of the papers. The aim of the symposium was not so much to discuss new material as to present a series of papers to educate scientists and engineers in the problems pertaining to high-altitude rockets and space-flight. In this the symposium was a success and this volume, although written before the first satellite was launched, gives the best survey of the field that the reviewer has yet seen and moreover at a very reasonable price. It might be noted here that following the stream of popular works issued during the past decade on missiles and astronautics there is now appearing a fair trickle of technical works (mostly American) on the same subjects. Almost without exception these are tomes of over 500 pages and, again almost without exception, they contain a great deal of irrelevant material and are not value for money. The potential buyer can be assured that in the present work every page is well worthwhile and that none of the authors has used padding.

The British papers are excellent but it is a great pity that our contribution to upper atmosphere ironmongery during the International Geophysical Year has been so meagre. Our only contribution, Skylark, which is fully described in Stephens' paper, seems almost a prehistoric monster compared with the small cheap rockets that have been developed in the United States and Japan. Bearing in mind the recent proposals to carry out space research jointly with the United States, it is to be hoped that Britain will not be left behind in this field of synoptic rocket research, even if we cannot alone develop major space vehicles.

Interesting points could be noted from any of the papers but there is room to discuss only two items. Professor Baxter discusses, among many other topics, the problem of multiple versus single combustion chambers for high-thrust installations. According to the square-cube law the total installed weight should become less as the size is reduced, that is as the number of units for a given thrust is increased. This relationship is not borne out exactly in practice as most items will not scale linearly. For example, nuts and bolts come in discrete sizes, and sheet metal is normally obtained in standard gauges rather than rolled to required thicknesses. Again there are limiting minimum sizes for certain items such as servo-control valves. The efficiencies of burners, nozzles and turbo-pumps also vary with size. The curve of minimum specific weight versus thrust thus exhibits a minimum at a finite thrust. The curve is in fact a very flat one and the minimum is shown to occur between 10,000 and 100,000 lb thrust. As the reliability of an assembly is inversely proportional to the number of units, it is evident that where a high thrust is required units giving thrusts in the region of 100,000 lb would be most suitable. It is interesting to note that although the Atlas, which was designed some years ago, is propelled by three units each giving about 150,000 lb thrust, one of the latest American contracts to Rocketdyne is for a single unit of 1,000,000 lb thrust indicating that the point of minimum specific weight has probably shifted up the scale considerably during the past few years.

Looking further into the future Dr. Shepherd, chairman of the British Interplanetary Society, deals with some of the more unconventional propulsive systems such as a working fluid heated by nuclear power, the use of free radicals and the use of nuclear power to produce a thrust-developing ion beam. He also considers the possible weights of vehicles for various voyages but improvements in structures have been so striking during recent years that his figures are rather pessimistic.

As might be expected these eminent authors commit no obvious errors in their papers and in the instances where more than one school of thought exists, the excellently edited discussions provide a record of the opposing point of view. The layout is similar to that of the *Journal of the Royal Aeronautical Society*, the paper and printing are excellent (only a couple of misprints have been noted) and the illustrations are clear, although the printing of some curves with no background grids is deprecated.

NEW BOOKS

Mobile Radio Telephones. By H. N. GANT. *Chapman and Hall Limited, 37 Essex Street, London, WC2.* (21*s*)

Written for those with less technical knowledge, from a commercial point of view. Deals with uses and limitations, performance requirements, installation, and maintenance and testing.

Structural Mechanics. By W. MORGAN and D. T. WILLIAMS. *Sir Isaac Pitman and Sons Limited, Pitman House, Parker Street, Kingsway, London, WC2.* (30*s*)

A first course in structures for students. Fundamental principles are covered with simplest mathematics. Exercises and answers are provided.

Methods of Testing Vulcanised Rubber. BS 903: 1950. *British Standards Institution, 2 Park Street, London, W1.* (21*s*)

To keep pace with industry this standard has periodic revisions the latest of which—A.12—replaces Part 31 and costs 5*s*. It covers the method for the determination of rubber-to-fabric adhesion (ply separation).

Reactions Between Aggregates and Cement. Part IV: Alkali-Aggregate Interaction: The Expansion Bar Test. By F. E. JONES and R. D. TARLETON. National Building Studies Research Paper No. 20. Published for the *Building Research Station, Department of Scientific and Industrial Research, by Her Majesty's Stationery Office, York House, Kingsway, London, WC2.* (4*s*)

Supplements Part III. Describes application of expansion bar test to examination of some aggregate for possible expansive reaction with high alkali Portland cements.

NYLON and TERYLENE in CONVEYOR BELTING

Two hundred and eighty-one thousand miles is a great length for a man-made fibre; such a yarn would in fact stretch from here to the moon, and it would take two seconds for light to travel from one end to the other. Staggering though such thoughts may be, this length of filament Terylene has been incorporated in five miles of conveyor belting which has just been shipped to the Soviet Union. Questions which justly arise in the mind of the potential conveyor user are—" why was Terylene chosen for this belt, and not nylon, rayon or cotton?" and " are such yarns likely to be of importance to me?" To persons asking such questions, this article is dedicated.

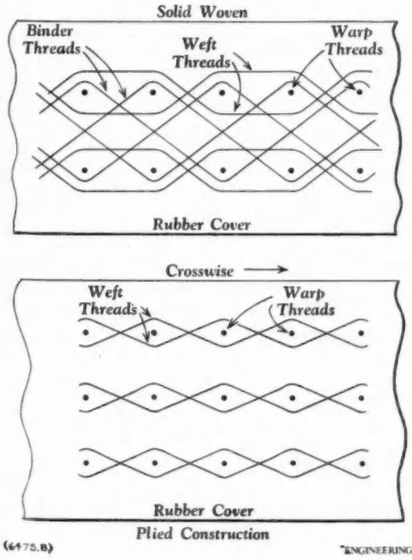
Fig. 1 This belt, operating in a gypsum mine, has a solid-woven reinforcement incorporating nylon.

Nylon is old (1946), Terylene is new (1955); both are making a large impact on conveyor reinforcement where cotton and small amounts of jute and viscose rayon have previously held the fort. New achievements must, however, be viewed in the knowledge that the serious industrial sales promotion of nylon for conveyor belting is only past its first birthday, but that of Terylene is past its third.

Conveyor belting needs little introduction, nor should it be necessary to stress the potential which it offers to the production engineer as a method of transport. Suffice to quote one user to illustrate the magnitude of the market; the National Coal Board is currently replacing 8 to 9 million ft of belting a year which is well over half the United Kingdom production. Of the trunk, gate and face belts which they use the wear on the last is the worst: 50 lb lumps of coal are regularly thrown on to a moving belt which is often not supported on idlers but is being dragged on the seam floor. Obituary notices appear after 2 to 3 months and a life of 9 months is considered outstanding. The NCB are therefore trying nylon and Terylene. Through a limited approval scheme, manufacturers of belting are being encouraged to incorporate new yarns.

The NCB are operating with belts which all fall into one category, i.e. where their life is short and the operating conditions are severe; increased life is here worth a premium. Yarn and belt manufacturers discern another category as being general purpose belting where reasonable life is assured, and where the premium is on reduced cost with the same performance. High tenacity Terylene and nylon yarns fulfill the demands for improvement in both categories. Generally speaking, the tenacity* of these yarns is about double that of cotton, and duck woven from them has 2 to 4 times the strength for a given weight. Their incorporation in conveyor belting, therefore, allows increased strength for the same weight, or decreased weight and cost for the same strength.

Fig. 2 Construction of belts.



YARNS AND BELT MANUFACTURE

All nylon 66 is of one molecular composition and structure but is produced by British Nylon Spinners as five distinct types of yarn; known as types 100, 200, 300, 500 and 600, they have different surface lustre for different applications and differ in tenacity as a result of variations in the draw ratio during manufacture. Of these, types 300 and 600 are high tenacity yarns made for industrial purposes.

Terylene polyester filament and yarn are made by Imperial Chemical Industries; medium tenacity yarns are designated Type N and high tenacity yarns Type F. High tenacity rayon has been incorporated in conveyor belting, but whilst apparently offering increased strength, such advantages are not fully realised in the belt.

The two main types of reinforcement are solid-woven or of a plied duck construction, and the lay of the fibres is illustrated in Fig. 2. Solid-woven belts do not suffer from ply separation (delamination) but are up to one-third more expensive than plied belts of the same strength. They are suited to severe usage and presently constitute 10 per cent of all belting used in the coal-mining industry, being found especially at the coal face.

In 100 per cent man-made reinforcement, nylon or Terylene constitute, of course, both weft and warp. In belting reinforced with, say, 30 per cent nylon, it is usual for much of this to go into the weft or cross-wise threads to give adequate tear strength and abrasion resistance in this direction; Terylene, on the other hand, has in the past been incorporated mainly in the warp, or longitudinal, threads.

* Tenacity is a measure of the strength to weight ratio. It is expressed in grammes strength per denier, where the denier of a yarn is the weight in grammes of 9,000 metres of yarn.

An overworked objection to all-nylon or all-Terylene reinforcement is the high cost of yarn pretreatment processes, but these do, in fact, only contribute a maximum of 5 per cent of the final product cost. Still, in a cut-throat market this is important, and advantage is being taken of the good bondability of cotton to pvc and rubbers, and the possibility of mechanical adhesion by suitable yarn treatment to avoid the use of bonding pretreatment. A peep inside the research laboratories will reveal that present developments in this direction are a single filament yarn wrapped in one or two directions with cotton or nylon staple, and a bulked yarn. These *composite yarns* are of course distinct from the plain filaments which are at present woven into *composite ducks*. Note that only two of these developments offer an alternative to adhesives, if a 100 per cent man-made reinforcement is to be retained.

Surfacing materials can be classed as ordinary or expensive, and use of the latter is sometimes justified; the working tolerances of the elastomers are summarised in Table I. The cover is what comes into contact with the conveyed load, not (usually) the reinforcement, and the choice of correct cover for conveying chemicals or hot materials is important.

TABLE I.—*Working Properties of Covering Materials*

Material	Working temperature, °C	Remarks
Natural rubber	100	General purpose
Butyl	120–140	Particularly good for hot applications
Pvc	70–100	Softening point depends on plasticiser—non-inflammable
Neoprene	180–250	Not affected by oils and greases, non-inflammable
Thiokol	70–100	
Nitrile (vulcanised)	150	
Silicone rubber	150–200	Has been used with glass fibre reinforcement for oven conveyors

YARN PROPERTIES

The question underlying any comparison of yarn properties is whether these have any meaning in terms of better belt performance. Some outspoken claims might well be questioned as to their relevance.

Cost: Nylon and Terylene, at 130 and 126*d* per lb are approximately two to three times as expensive as cotton at 42*d* per lb, and high tenacity rayon at 55*d*.

Mechanical properties: Tensile strength has always been regarded as an important property, perhaps because it is the easiest to measure. A comparison of tenacity is made in Fig. 3 and further properties are summarised in Table II. From these it should be

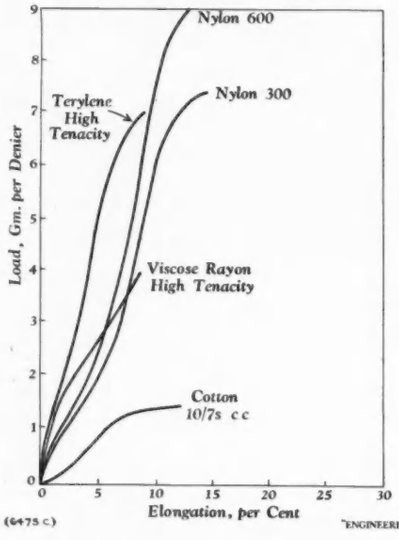
TABLE II.—*Principal Properties of Yarn Used for Belting*

	Nylon 600	Terylene high tenacity	Viscose rayon high tenacity	Cotton*
Tenacity, dry, gm per den	8·8	6–7	3·5–4·5	3·0–6·0
Tenacity, wet, gm per den	7·9	6–7	2·6–3·4	3·3–6·6
Load to give 1 per cent extension, gm per den	0·4–0·8	1·3	0·8–1·2	0·5–0·6
Specific gravity, gm per cu. cm	1·14	1·38	1·52	1·50
Moisture regain at 65 per cent rel. humidity and 77° F, per cent ..	4	0·4	13	8

* Fibre properties; figures for cotton yarn are lower

clear that the tenacity of nylon 600 is greater than that of Terylene, and that both are better than viscose rayon or cotton. Moisture affects the strength of nylon but not Terylene, and it severely upsets rayon.

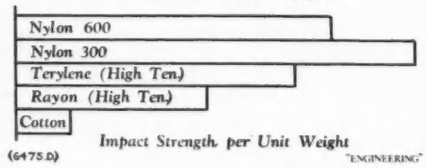
Fig. 3 Load-elongation curves for industrial textile yarns. (Rate of load application 0·5 gm per den per sec.)



The load which gives 1 per cent extension is a measure of the modulus. High tenacity Terylene has two to three times the modulus of nylon, and this is important as it gives a lower extension under load, but gives lower energy absorption. Fig. 4, in fact, compares the energy absorption of filaments, and cotton is seen to be rather poorly disposed.

At this half-way stage it can be seen that the

Fig. 4 Impact strengths of yarns.



strengths of nylon and Terylene are both potentially high, sufficiently so to offset their high cost compared with cotton. The increased strength of the fibres is readily utilised in a belt, but the impact strength can vary according to how it is made up. The energy absorption of a belt depends on the extensibility of the duck, and this, in turn, can be increased markedly by severe crimping of warp by the weft. The low impact strength of cotton is, in fact, overcome in this way.

Generally, Terylene can be made-up into a stiffer belt with good but lower energy absorption than nylon, and this suits it for a different field of application, namely for belts operating between fixed centres where take-up is impossible or costly.

Recovery: when belts are loaded they extend, and it is important that when a loading/unloading cycle is repeated the belt should quickly return to the same length, otherwise "slack" will have to be taken up. The basic nylon fibres appear better than Terylene on this count (see Table III) for although

TABLE III.—*Recovery of Industrial Yarns*

	Extension caused by 10 × 5 lb load cycles, per cent	Extension recovered after 10 × 5 lb load cycles, per cent
Nylon 600, 840 den ..	5·0	95
Rayon, high tenacity, 1,650 den	3·6	38
Terylene, high tenacity 4/250 den	2·25	84

nylon extends more under tension, and sets more, this extension is more completely eliminated by recovery. Under constant loading recovery of the fibres and belting would be of little importance, but in belts carrying varying loads it is worthy of consideration.

Abrasion and fatigue: laboratory comparisons of yarns based on this property are not considered reliable in predicting actual performance of belting, but abrasion is of importance on the edges of mining belts and it is thus worth mentioning. Table IV illustrates that man-made fibres are good.

TABLE IV.—*Comparative Dry Abrasion Resistance of Textile Materials*

(Martindale Abrasion Tester: Grade O Emery Paper)

Weft	Warp	Construction	Rubs to first weft thread broken	Rubs to first warp thread broken
Rayon, 250 den	205 den nylon	4 end sateen 54 ends, 88 picks	1,935	5,463
Peruvian cotton, 1/20s c.c.	205 den nylon	4 end sateen 54 ends, 88 picks	2,560	6,230
Terylene, 250 den	205 den nylon	4 end sateen 54 ends, 88 picks	6,396	9,450
Nylon, 210 den, type 300	205 den nylon	4 end sateen 54 ends, 96 picks	9,965	14,733

When and if filaments rub one over the other they suffer from flex-fatigue, and loop tests performed under constant load illustrate, if nothing else, that nylon and rayon sadly deteriorate when wet (see Table V) but that Terylene is unaffected.

TABLE V.—*Resistance of Yarns to Flex-Fatigue*

Material	Filament Denier	Mean no. of cycles to break	
		Dry	Wet
Terylene	2	1,980	1,870
Nylon	3	8,800	3,890
Viscose rayon ..	2	880	28

Laboratory measurements of pure fatigue strength indicate that the properties of nylon and Terylene are very similar. No failure of a belt has yet been attributed to fatigue, so although it is possible that fatigue speeds failure by other means it appears to be unimportant on its own and no conculsions can be drawn.

Effect of temperature and heat: at elevated temperatures the modulus and tenacity of nylon and Terylene are reduced as shown in Fig. 5. Moreover, prolonged heating has a permanent effect on the strength at room temperature. As indicated in Fig. 6, loss in strength of Terylene occurs above about 150° C, which is 50° C higher than with nylon. To put this in perspective it must be remembered that although a belt may carry a hot load, the rubber coating acts as an insulative layer, and with the usual air cooling on the underside of a belt the reinforcement temperature will seldom exceed 100° C without prior deterioration of the rubber covering.

Chemical resistance: both nylon and Terylene are resistant to chemical attack and only three points are worth considering in a comparison. First that nylon is attacked by acids and Terylene by alkalis; second that they are both superior to cotton and rayon; and third that their low moisture pick-up means that rubber covers can more easily be repaired (on the dry 100 per cent artificial reinforcement) than where moisture absorbent cotton is incorporated. This last point offers an incentive to use the all man-made fibre belt.

CASE HISTORIES

An interesting analysis of costs has resulted from the use of Terylene reinforcement in a belt installed by ICI Lime Division in a quarry in North Wales. This belt carried limestone rock direct from the jaw

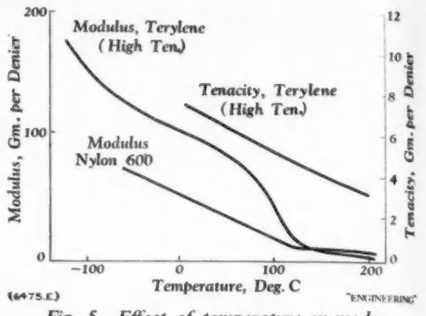


Fig. 5 Effect of temperature on modulus and tenacity of industrial yarns.

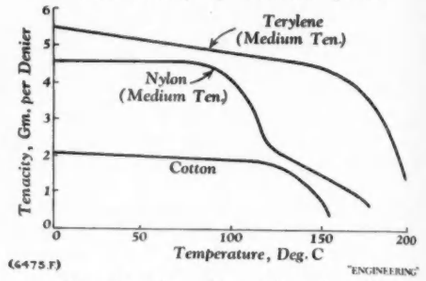


Fig. 6 The effect of prolonged heat on the tenacity of Terylene, nylon and cotton fibres measured at room temperatures. (Exposed for 72 hours.)

crushers under wet conditions. The belt had a life of 2½ years compared with 1 year for a cotton reinforced belt which it replaced. The summary in Table VI indicates that the cost per ton of load conveyed was reduced by half over a three year period.

TABLE VI.—*Analysis of Costs of Belt in Limestone Quarry*

	Terylene	Cotton
Cost of belt, £	396	670
Installation costs, £	30	90
Maintenance costs, £	83	240
Total costs, £	509	1,000
Average tonnage carried per hour ..	183	170
Max. tonnage carried per hour ..	253	200
Cost per 1,000 tons carried	11*s* 8*d*	20*s* 10*d*

The belt, incidentally, was 30 in wide with five plies of 32 oz duck. It was rubber covered and its success was partly attributed to the high adhesion of the rubber coating and the ease of maintenance. The belt was removed when it was no longer economical to repair the cover, though little carcass damage had occurred: and the belt has in fact been recovered, which ICI describe as a unique procedure.

The first illustration shows a nylon reinforced solid-woven belt in use in a gypsum mine. 100 per cent Terylene reinforced belt has been used to advantage for the conveyance of various chemicals. One of these transporting adipic acid filter press cake has outlived a cotton belt by nearly six times with a life of 13 months compared with 10 weeks.

CONCLUSIONS

There are many manufacturers of plied and solid-woven belting, most of whom are marketing or developing belts incorporating nylon or Terylene, and, as always, it is best to consult them on the best type of belt for a proposed new installation.

There is little doubt that nylon and Terylene have much to offer conveyor belt manufacturers and users in performance and reduced cost; the differences between the fibres is slight compared with their vast superiority over staple fibres such as cotton, but there are certain applications where a choice should be made. These occur in conveyors for handling chemicals, for genuine high temperature operation and where allowable stretch and recovery are dictated by existing plant.

The trend and main aim in the industry is to develop all-nylon or all-Terylene reinforced belting, to which the only real objections are the increased flexibility of the thinner belts (of same strength) or the increased cost of the belt (of the same weight). The first will undoubtedly be overcome when bulked or wrapped yarns are perfected, and the second is not really existent, because a true analysis of costs per ton carried will indicate overall savings where nylon or Terylene have been properly incorporated.

A COMPUTER PROGRAMME FOR POWER TRANSFORMER DESIGN

By M. A. SPURWAY, A.M.C.T., A.M.I.E.E., Transformer Department, Ferranti Limited

The design of a power transformer centres on the core and windings, which must be arranged to provide the performance characteristics required by the customer. In addition to the output rating and voltage ratio, the specification normally includes the reactance, no-load loss, full-load loss, insulation levels and temperature rise.

Before considering the size and arrangement of the conductors forming the windings, the designer must first assess a number of parameters, many of which are interdependent. These parameters include the leading dimensions and flux density of the core and the leading dimensions and current density of the windings. Later, when the windings have been designed in detail and the performance characteristics calculated, errors in the choice of parameters are revealed and the design must be modified accordingly. When preparing a design for quotation purposes the arrangement of the conductor is not of great importance, providing that the parameters can be accurately determined. From these, the weight of material and the cost can be very closely estimated.

Thus the above parameters constitute a preliminary design, complete in itself for quotation purposes and an essential step in preparing the final design.

A programme has been prepared which enables an automatic digital computer to make a preliminary design with the accuracy of a very experienced designer but in a very much shorter time. The machine used is the Ferranti Pegasus automatic digital computer.

To produce a design, the specification for the required transformer is given to the machine as an input data tape. After the necessary calculation, the output data are first punched on paper tape and then converted into normal typewritten characters by a teleprinter.

INPUT DATA

The input data required for each design are shown in Table I. Of the 41 items, 11 can normally be taken direct from the customer's specifications and the remainder must be provided by a designer. The items marked with an asterisk are optional and are normally given as zero, the machine providing a value.

The input data requires no leading dimensions, so that the programme is free to provide a design without being "prejudiced" by the designer, who does not have to "anticipate" the final design. The programme also accepts a second form of input arranged to save time in the preparation of input tapes. After supplying the full input data any item or items in the list can be altered by quoting the reference number and the new value. Since the input data remain unaltered at the end of each design calculation, these data can be modified and the calculation recommenced by using the second form of input, that is, without repunching the whole 41 items. The output is shown in Table II.

CORE CROSS SECTION

The programme provides three methods of choosing a core area:

(1) The normal method is for the programme to select the core area from a table of standard cores previously prepared and supplied to the machine. Several core tables can be stored, each table containing a range of cores of a particular type. The designer specifies in the input data the core table to be used, i.e., he selects the type of core but allows the machine to select the core area.

(2) If the designer has reason to believe that there is no appropriate standard core, the programme will "make up" cores. The designer specifies the ratio of leg area to yoke area and leaves the programme to select a non-standard core area.

(3) The core may be specified by the designer. If it is a standard core he provides the core table reference, if a non-standard core he must specify the ratio of leg area to yoke area.

The core tables contain the following data for each standard core:

(1) Net cross-sectional area of core.
(2) Internal diameter of smallest insulating tube which can be fitted over the core.
(3) Ratio of leg area to yoke area.
(4) Distance between the edge of the largest plates in the core and the inside of the smallest tube (Item 2).
(5) Constant for calculating weight of yoke.
(6) Depth of yoke.

For non-standard cores these data are calculated for the selected area.

The desired operating characteristics do not in themselves fix the core area, though they limit the range of possibilities. Within this range it is naturally desirable to choose the core area which results in the minimum cost for the complete transformer. Fig. 1 indicates the change in cost with variations of core area for a particular transformer and shows that the core area can be varied over a wide range without an appreciable change in cost.

Thus the precise solution to a complicated optimisation formula is of little value and the selection of the core area is a matter of choosing

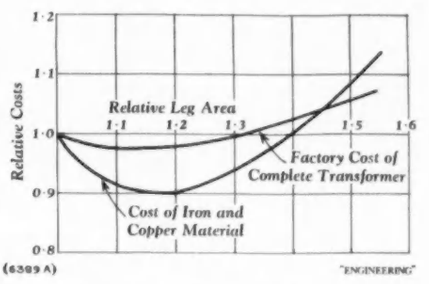


Fig. 1 Variation of cost with core area for a particular transformer.

a convenient size between two limits. For a specified reactance and load loss the proportion of the frame (i.e. the ratios between the core diameter, leg length and window width) vary as the core area is altered.

The programme bases the preliminary selection of area on these proportions, using the core area which gives proportion nearest to the "ideal" values. The ideal proportions are themselves chosen by analysing a number of hand designs, and therefore reflect the design office experience in choosing the core area. Since the load loss and reactance are not the only characteristics required, the preliminary choice of core may be subsequently altered, as explained later, the effect being that the programme is influenced to depart from the ideal core in the same way as a designer would be.

WINDING SPACE FACTOR

Since the programme does not design the windings in detail, its success depends on the accuracy with which the winding space can be assessed.

The winding space is occupied by conductor, insulation and cooling ducts. If the ampere turns and current density are known the space occupied by the copper can be determined. The

TABLE I.—*Input Data*

Reference	
1	MVA
2	Number of legs with windings
3	Frequency
4	High voltage
5	High voltage winding connection
6	Low voltage
7	Low voltage winding connection
8	Percentage tertiary winding
9, 10	Tapping range
11	Guaranteed no-load loss
12	Guaranteed full-load loss
13	Guaranteed reactance
14	Position of tapping windings
15, 16	Type of windings
17	Type of cooling
18, 19, 20	Axial end clearance between windings and yoke
21, 22, 23, 24, 25, 26	Radial clearance between windings
27, 28	Eddy loss (percentage)
29	Tank loss
30	Type of iron
31, 32	Type of conductor (copper or aluminium)
33	Maximum flux density
34, 35	Maximum temperature rise of windings above oil temp.
36	*Maximum current density
37, 38	*Maximum radial depth of windings
39	*Maximum leg length
40	*Cross-sectional area of core
41	Core Table Reference or Ratio of leg area to yoke area

TABLE II.—*Output Data*

Reference	
1	No-load loss
2	Iron weight
3	Full-load loss
4	Conductor weight
5	Overall height of core and windings
6	Overall width of core and windings
7	Overall length of core and windings
8	Total weight
9	Cross-sectional area of core
10	Cross-sectional area of yoke
11	Flux density in leg
12	Length of leg
13	Leg centres
14	Window width
15	Length of core
16, 17, 18	Axial length of windings
19	Internal diameter of tube over core
20	Radial depth of tertiary winding
21, 22	Internal diameter of windings
23, 24	Radial depth of windings
25, 26	Outer diameter of windings
27	Clearance between low and high voltage windings
28, 29	Length of mean turns
30, 31	Current densities
32, 33	Voltage per winding
34, 35	Current per winding
36, 37	Turns per winding on normal tapping

total space can then be found by applying a space factor,

$$\text{total space} = \frac{\text{copper space}}{F}$$

The overall space factor F can be subdivided into two factors, a wire factor F_w which allows for the insulation on the conductors and a duct factor F_d which allows for cooling ducts. Thus

$$F = F_w \times F_d$$

The wire factor varies with the thickness of the insulation, the cross-sectional area of the wire and the shape, but a reasonable approximation can be made by regarding it as a function of the insulation level and thus of the voltage of the winding.

The duct factor is more complex and depends on the heat loss in the windings and the maximum temperature rise permissible between the winding and the cooling medium which surrounds it (usually oil).

A formula to calculate F_d has been derived and has the form

$$F_d = C\,M + \frac{N - R\,C}{N\,C + S}$$

$$\text{where } C = \frac{\text{Winding rise}}{P\,\Delta^2\,E\,F_w} \times \frac{10^6}{r}$$

where Δ, current density in winding,
E, depends on eddy loss in winding,
r, resistivity of conductor material.

M, N, P, R, S, are empirical constants, the value of each depending on the manufacturer's standard practice in the provision of cooling ducts and the calculation of winding temperature rise.

Though not a rigid solution, this equation gives results which are sufficiently accurate.

DESIGN METHOD

The design calculations require values for two sets of factors. One set are those which allow for tappings, inter-star connections, etc., which are constant for a particular transformer and are calculated at the start of the programme. The second set are design variables such as the winding space factors, the ratio of the lengths of mean turn of the windings, and the ratio of the axial lengths of the windings. Assuming arbitrary values for these factors, the programme calculates minimum and maximum core areas.

For standard cores the machine refers to the appropriate table and calculates the frame proportions for each core in turn, starting with the smallest core area within the limits, and selecting the area which gives proportions nearest to the ideal. For non-standard cores the programme uses a similar system, starting at the minimum core area and investigating cores as before. In this case each successive core area investigated is a fixed small percentage larger than the previous one.

Having chosen a core, the programme completes the calculation of winding dimensions and current density, but the approximation may not be very close at this stage, since the design is based on arbitrary values of the design variables referred to previously. A better approximation is obtained by using the design just completed to provide calculated values of these ratios and repeating the whole process, including the selection of the core area.

The programme thus starts an iterative process, using the factors from one design to compute the next design, until two successive designs have negligible differences. At this point the iteration stops and the machine has provided a set of coil dimensions, with the appropriate current density and number of turns, all chosen to give the specified reactance and load loss.

The frame dimensions are now " rounded up " and the weight and no-load loss calculated, the programme distinguishing between hot-rolled and cold-rolled steel and between interleaved and mitred-core construction. A series of tests now ensure that the design complies with the input specification. If the design fails to pass any of these tests, appropriate modifications are made and the iterative process is repeated to complete the design with the new conditions. Successive attempts may fail at different tests, but the modifications are so arranged that the programme can always find an " acceptable " design, and this final design is the one given in the output data.

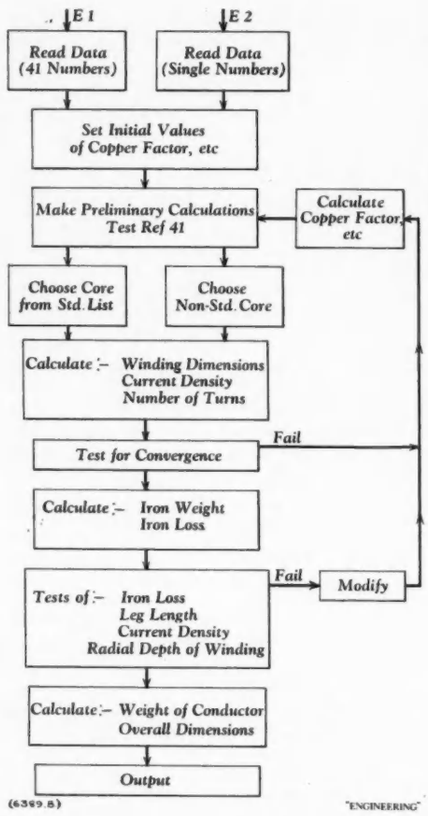


Fig. 2 Programme for preliminary design of a power transformer, simplified block flow diagram.

In practice, the machine time required is one to two minutes per final design, depending on the number of iterations required. The value of the results obtained depends chiefly on the programme choosing the correct core area and making an accurate assessment of the space required for the windings.

Table III shows a comparison between typical results obtained by the computer and the detailed designs produced by a designer.

PROGRAMME ASSEMBLY

The programme consists of about 3,800 separate orders, together with constants and tables, and these are arranged into 22 " routines" and seven " sub-routines." Each routine carries out a particular operation (e.g., calculate no-load loss) and may use one or more sub-routines. The routines are joined together by a master programme which " calls in " the appropriate routine at each stage, as shown in Fig. 2. This arrangement simplifies testing and correcting the programme and provides scope for subsequent improvement and development.

The master programme, sub-routines and data are stored in the first 127 blocks of the main store. Important features of the programme are its inherent versatility and the scope that it offers for further development. It can deal with a very wide range of transformers, both as regards output rating and voltage class, and will produce designs using either copper or aluminium conductors. Different types of windings are catered for and the programme can quickly be extended to include new winding techniques, the only requirement being a method of estimating the space factor.

To provide the empirical values required in the programme it is usually necessary to analyse a number of designs. For some types of windings, computer programmes are available which design the coils in detail, and by using these a large number of suitable specimens can be considered. Where only a few " hand " designs are available for this purpose, however, the loss in accuracy is not serious.

TABLE III

MVA	High voltage	Discrepancy, per cent		
		Leg length	Core weight	Conductor weight
100	132	+1·0	+1·3	+1·8
2·5	33	0	−0·4	+0·3
32·5	132	0	−0·4	−1·0
5	28	+1·9	+1·0	−1·7
30	132	−1·2	+0·2	−2·0
10	66	+2·7	+1·3	+2·7

$$\text{Discrepancy per cent} = \frac{\text{Machine's value} - \text{Designer's value}}{\text{Designer's value}} \times 100$$

CONTRIBUTION TO DESIGN WORK

To use the programme a designer completes an input data form and passes it to an operator, who prepares an input data tape. After passing through the machine the typed output can go straight back to the designer. The whole process occupies about fifteen minutes, the elapsed time depending on the availability of the computer and the office organisation.

For particular designs the programme provides a full set of parameters from which the final design can be prepared. The designer can concentrate on the details of the windings and insulation, knowing that the performance characteristics will be met within very close limits. The programme thus shortens the time taken and may enable a better design to be prepared.

For quotation purposes the programme provides nearly all the information required for estimating the cost of the core and windings. It is particularly useful when comparisons are required between different designs. Having compiled the input data for the basic design, the designer can specify rapidly the alternatives he wishes to investigate. By using the second method of input, the tape punching for each alternative is very short, thus, for example, six possible designs for the same basic transformer can be produced in about thirty minutes, whereas by hand they would require one or two days.

Large scale investigations can be carried out with a thoroughness previously impossible. The element of repetition considerably shortens the time required for each design. In one recent investigation 228 designs were considered, comprising 12 variations of each of 19 basic transformers. The times required were as follows:

Compiling the input data ..	5 hours
Average per design ..	1·3 minutes
Punching the input data ..	3½ hours
Average per design ..	0·9 minutes
Machine time	4¾ hours
Average per design ..	1·25 minutes

Thus the average time required for each design was 3½ minutes.

When comparisons are required a valuable feature is the consistency of the results. Individual designers' " idiosyncrasies " do not have to be taken into account when the results are analysed. The overall effect of the computer is to increase the amount of useful information available in the design office, to make information available much more quickly and, by freeing designers from routine calculations, to increase the time which can be spent on other aspects of the design.

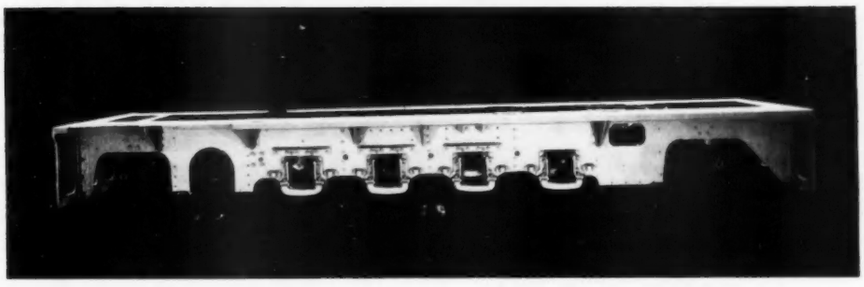
ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance of Mr. H. L. Thomas, B.Sc.(Eng.), M.I.E.E., and Mr. K. S. Rowe, B.Sc.

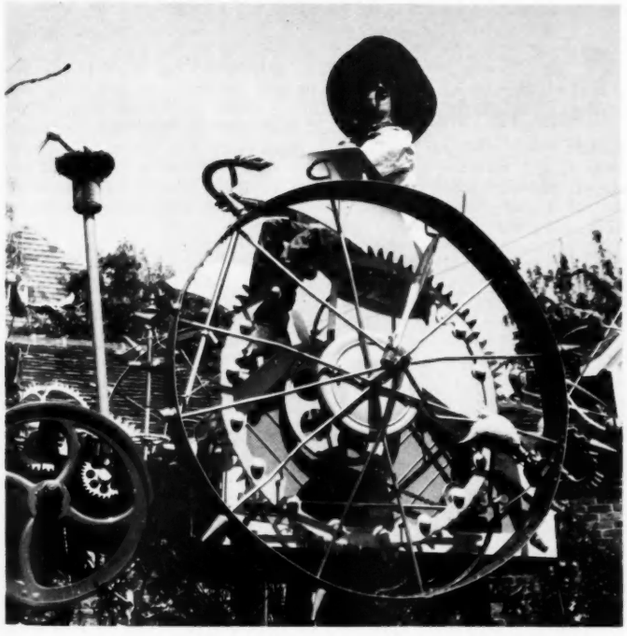
Combining luxury with a practical layout suitable for temperate or tropical waters, the 60 ft Viking Series 2, twin-screw yacht, was designed for optimum seaworthiness and a cruising speed of 14 knots.

World's largest crane, designed for positioning prefabricated pressure vessels at Hinkley Point.

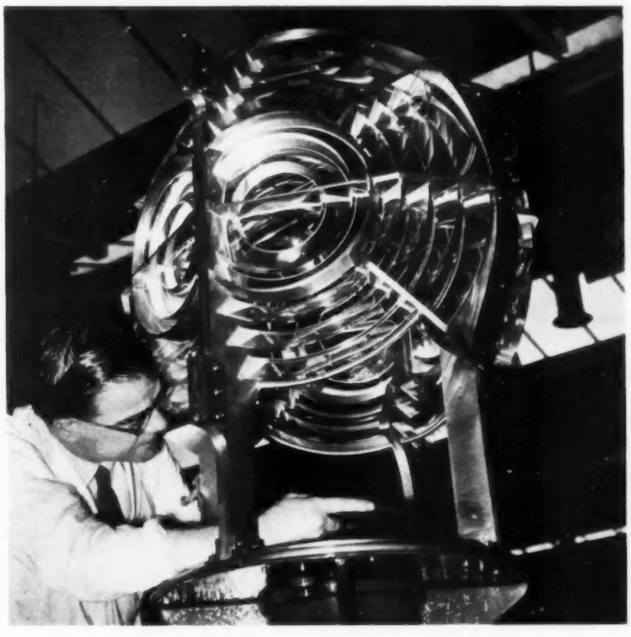
Longfellow 1 gallon polythene greenhouse can with balanced handle. In red, green or yellow.



Underframe of diesel-hydraulic locomotive during erection in the shops. It is of open-hearth steel in one plate running the whole length of the locomotive, suitably braced and bracketed to give rigidity.



This working model of a tractor was designed by Rowland Emett to show lightheartedly the advantages of the B.90 exchange scheme for farmers.



The paraffin burners in the 77-year old Eddystone lighthouse are soon to be replaced by this up-to-date equipment of half a million candle-power.

MINIATURE DRIVES

A series of miniature power drives has been developed by Tiltman Langley Limited, Redhill Aerodrome, Surrey.

Designed to perform various functions, they can be used as clutches, freewheels, backstops or dual drives.

As clutches for providing a non-slipping drive, they have many applications where power transmission has to be controlled, or a sequence indexed. As explained here, control is by a pawl operated mechanically, hydraulically, pneumatically or electrically, depending on customer's requirements. Manufactured from alloy tool steel, accurately ground, they are unaffected by oils or fluids.

The dual drive unit provides two inputs, the primary and the secondary. The primary drive takes the normal power but when the power source is stopped, the driven member can be rotated in either direction by the secondary drive, without any movement of the power source. This makes it suitable for an application where the power source may be off and the driven member has to be moved for adjustment purposes.

The design has been engineered in such a way that, from a kit of parts, the customer can himself assemble clutch, freewheel, backstop or dual drive, just by selecting the right parts, as all components are interchangeable.

Housing (1) is the driving member, shown working in an anti-clockwise direction. Fig. 1 (*a*) shows the clutch free. When the control wheel (3) is held stationary by the operating pawl (2), it prevents the rollers (4) from being driven into the wedge formed by the housing (1) and the cam (8), the driven member.

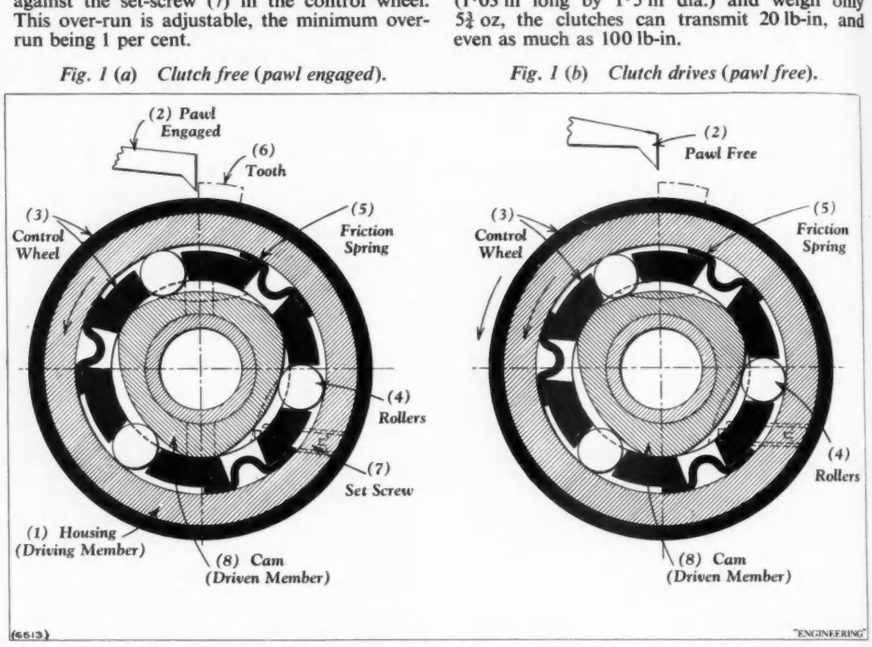
When the pawl (2) is free, as in Fig. 1 (*b*), it releases the control wheel (3) which is moved anti-clockwise by the friction springs (5) between the control wheel and housing (1). The rollers are thus engaged.

On stopping the control wheel (by engaging the pawl) the rollers and the clutch are freed.

When the clutch is free (control wheel stationary) the driven member (cam) is prevented from over-running by the concave recess coming up against the set-screw (7) in the control wheel. This over-run is adjustable, the minimum over-run being 1 per cent.

The clutch is thus controlled by the pawl engaging with a tooth (6) or teeth in the control wheel, the number of teeth being determined by the operation required. One tooth will give either one or more full revolutions of the output shaft (according to the frequency of pawl engagement) whilst multi-teeth give fractions of a revolution, either by fitting a maximum of 4 teeth to the control wheel or by fitting a multi-tooth control wheel. Although they are small (1·03 in long by 1·5 in dia.) and weigh only 5¾ oz, the clutches can transmit 20 lb-in, and even as much as 100 lb-in.

Fig. 1 (a) Clutch free (pawl engaged). *Fig. 1 (b) Clutch drives (pawl free).*



FLAT BOTTOM RAILS AND FISHPLATES

A completely new family of railway rail sections has come into being with the issue of revised editions of BS11: 1959, *Flat Bottom Railway Rails* and of the related standard BS47: 1959, *Steel Fishplates for Railway Rails*. The new rails are those in the weight range of 65 lb up to and including 110 lb per yd. They will be referred to as the "A" series. (The new standard does not specify sections for rails in the 115 to 120 lb per yd range. Sections remain unaltered in the range of 25 to 55 lb per yd and also for the 60 lb rail which is covered by an amendment to a previous edition.)

Since the existing series of FB rail sections was introduced 30 years ago, rail mounting on sleepers has changed and considerable knowledge has been acquired regarding the distribution of stresses within the rail itself. Experience has shown that:—

(1) Very high stresses can arise in the fillets joining the head and foot of the rail.

(2) High stresses can be induced in the vicinity of bolt holes under the wedging action of flat fishing angles.

(3) Unequal top and bottom fishing angles lead to differential wear, resulting in tilting of the fishplates and deterioration of the joint.

(4) Better disposition of available metal can be obtained by reducing the foot width, without affecting stability or giving an inadequate bearing area.

British Railways designed their 109 lb rail on similar studies and as it has given a good performance in 7,000 miles of intensively loaded track, BSI adopted it as a basis for the whole of the A series. The British 109 lb rail was also adopted by the International Union of Railways, with only minor alterations for continental use, as the UIC 54 kg per m rail.

The new rails have larger fillet radii than the old ones, and generally speaking the metal has been distributed to reduce high stress concentration rather than to maintain a high second moment of area and corresponding high beam section. With the re-design of the heavier rails, fishplates have also been improved. In particular, to strengthen the head of the fishplates where fractures were most frequent, more material has been put into the head and the bolt holes lowered below the neutral axis.

Copies of the standards can be obtained from the Institution, 2 Park Street, London, W1: BS11 is 17*s* 6*d* and BS47 20*s* (postage extra to non-members).

EXTRUDABILITY CHARTS

To help in the design of extruded rubber products, engineers in the Inland Manufactung Division of General Motors Corporation (according to an article by G. William Beck in a recent issue of the corporation's journal) have prepared extrudability charts. The one given here shows hardness plotted against tensile strength in relation to the minimum practical uniform thickness (*t*) and tolerance (Tol). It will be seen that closer tolerances and thicker cross-sections are possible when harder grades of rubber are used.

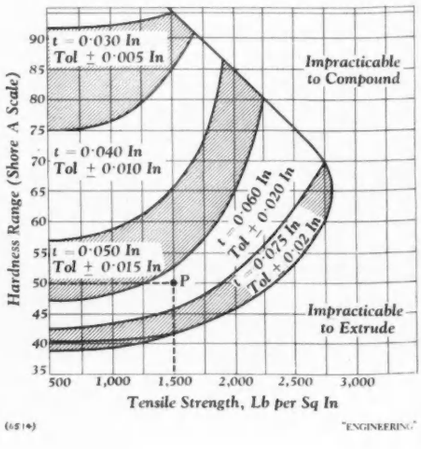
As an example of how to use the chart: a designer may know from experience that a rubber compound with a certain hardness and tensile strength is best for a product. He can spot these two values on the chart (point P in diagram) and then find the minimum practical thickness that can be extruded, and the tolerance. Similarly, if a certain uniform thickness is called for, the chart tells him the hardness and tensile strength he will need.

Another type of chart (not shown here) gives the same factors for extrusions with a wide variation in section thickness.

A word of caution: the charts are only meant to serve as a guide to the designer.

Hardness range (Shore A durometer) is plotted against tensile strength. The areas enclosed by the curved lines are the limits for any particular minimum thickness(t) and tolerance (Tol).

Example: *A rubber must have a Shore A hardness of 50 and a tensile strength of 1,500 lb per sq. in (point P). The chart shows that it can be extruded with a minimum thickness (t) of 0·060 in and a thickness tolerance (Tol) of ± 0·020 in.*



Operation and Maintenance

FLAME HARDENING IN USE

The Peddinghaus Process

The principle of flame hardening is well known, and the process is firmly established, but it may not be generally realised how versatile it is. Paul Ferd. Peddinghaus, Gevelsberg, Westfalia, Germany, who developed the oxy-town gas flame hardening process originally for use in their own works, now have a range of machines which will deal with many different types of hardening on flat, circular or contoured components. Town gas continues to be the heating medium in many cases, the gas being of uniform quality, reasonably inexpensive and obtainable in most industrial areas. Other types of gas can be used equally well, however, and the equipment can be adapted for use with natural gas, propane or acetylene without difficulty.

The original Peddinghaus machine was designed for flame hardening the jaws of drop-forged vices and the faces of anvils, of which Peddinghaus were, and still are, large manufacturers. Their original experiments soon led to the introduction of automatic flame hardening machines for their own products, and the process was adapted for use in industry generally, a surface hardening department of the company being set up to deal with development, design, production and marketing of flame hardening machines. This department of the Peddinghaus business is represented in Great Britain by Surfard Limited, 15 Wilton Road, Westminster, London, SW1.

FLAT SURFACES

Vice jaws and anvil faces, for which the Peddinghaus process was first developed, are typical examples of products which can be surface hardened by the controlled traverse across the face of a suitably shaped oxy-town gas burner, followed immediately by water quenching jets. If the output warrants it, a machine can be designed specially to deal with a product or a group of similar products, fully automatic control and air-operated fixtures making it possible to use unskilled labour for the operation of the machine.

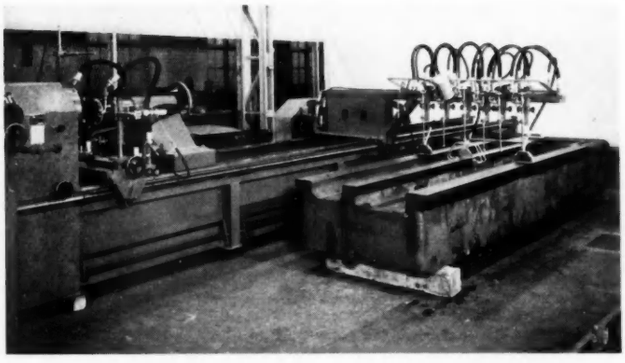
Lathe and other machine tool beds can be flame hardened by a machine which traverses the burners and quench head across the surface to be treated at a speed of 4 to 5 in per min, the gas, oxygen and water supplies being controlled automatically by solenoid valves.

Since temperature control is vital, Peddinghaus have developed a very fast reading optical pyrometer, the "Milliscope," which can be applied to any of their machines. The Milliscope operates on the incandescent lamp pyrometer principle, and compares the radiation from the heat source being measured with that from a calibrated lamp. Small variations above and below a pre-set figure are indicated on a dial. It is possible to control the hardening operations manually, using the dial as a guide, but the obvious course is to couple the instrument by means of relays to the traverse gear of the burner and quench unit, and so to control the hardening fully automatically. This is the usual procedure.

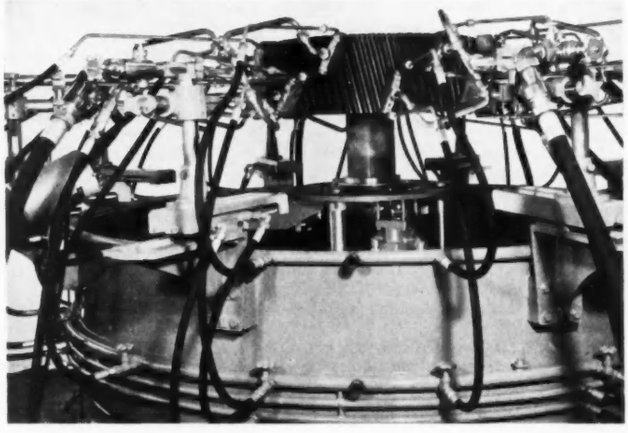
CIRCULAR SURFACES

If the traversing burner and quench unit is made in circular form and the machine is provided with a mechanism for holding and rotating a circular object, progressive hardening can be carried out on any type of roll or similar component; automatic control is equally applicable. A universal machine is available which, by means of interchangeable burner and quench units and extension arms, can deal with either flat or cylindrical surfaces as required.

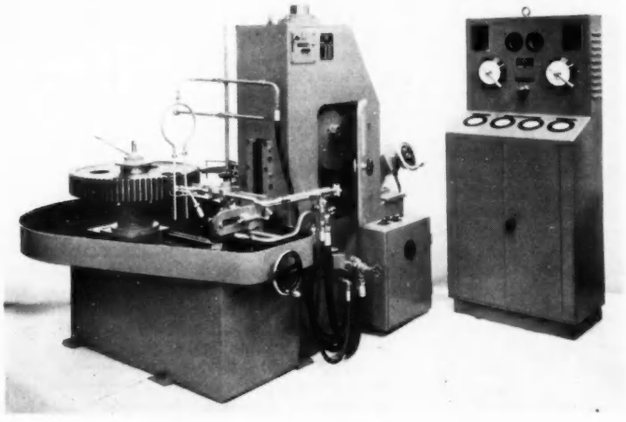
Smaller, wheel-shaped bodies, such as guide rollers, crane wheels, tyres, or grinding mill rings, can be dealt with on a horizontal spindle machine, which again can be fully automatic, and can cover a wide range of components; a



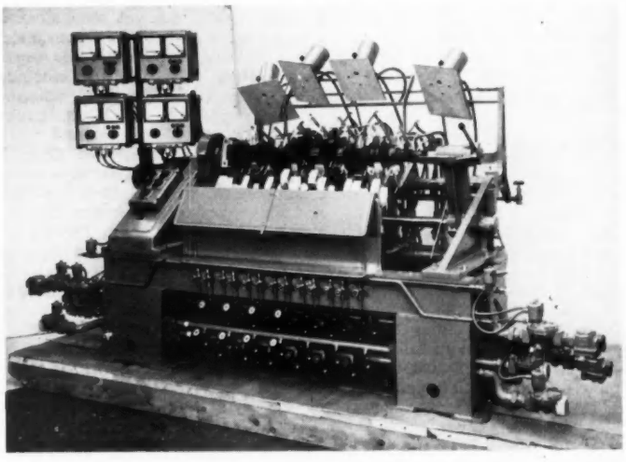
(Above) Peddinghaus universal hardening machine, which will deal with cylindrical objects or, as shown here, with flat surfaces.



(Above right) This spin hardening machine, for gears up to 60 in diameter and 10 in face width, is the largest of its type yet made.



Automatic machine for progressive hardening of gear teeth from 6 to 1¼ D.P. and from 1¼ to 9½ in face width.



Several crankshaft bearings are flame hardened simultaneously on this special purpose machine.

typical machine takes diameters from 4 to 40 in. Variable speed drive allows for spin hardening of smaller parts and progressive hardening of larger ones.

SPUR AND HELICAL GEARS

The universal flame hardening machine will deal with gears, both of the spur and helical types, and with sprockets or other toothed components, and so will the vertical spindle machine, which is particularly applicable to short shafts and bushings as well. But for regular use on gears, special purpose machines are also available.

Gears can be flame hardened in more than one way. Generally speaking, gears from 2½ D.P. and smaller are hardened by the spinning method, in the same way as a plain shaft. By this method the gear is spun mechanically in front of a burner or burners until all the teeth are at the hardening temperature, when the flame is cut off and the complete gear is quenched automatically. Spin hardening results in the teeth being hardened right through instead of on the surface only. Teeth of gears from 4 to 5 D.P. are generally hardened by the progressive method, that is, one tooth at a time, the quenching head following the burner head. For teeth of 3½ D.P. and larger, it is possible, by matching the burners accurately to the tooth space, to extend the hardened zone to the root of the tooth, so raising the fatigue limit by about 30 per cent. As with other types of flame hardening machine, those for gears can be arranged for fully automatic operation, manual work being confined to placing the gear in position and removing it after hardening.

SPECIAL APPLICATIONS

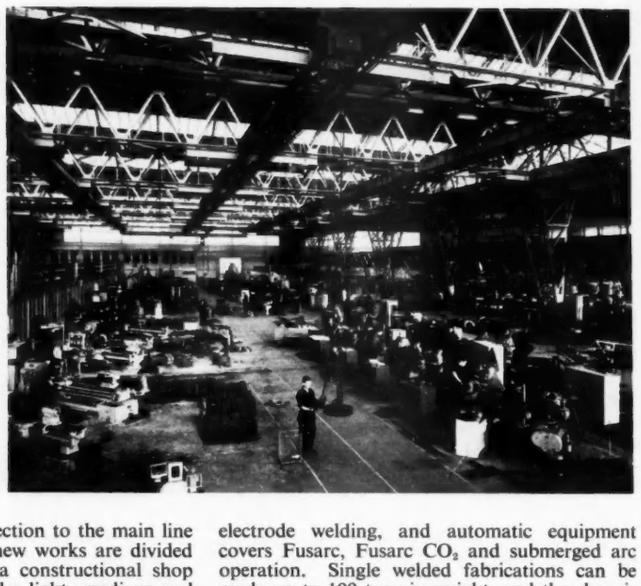
Many difficult shapes can be dealt with on machines which are basically simple. The crankpins and journals of an internal combustion engine crankshaft, for example, can be flame hardened on a vertical machine equipped with an indexing chuck to allow for the throw of the cranks. It will be necessary, however, to harden each journal and crankpin separately, moving the machine head after each operation. Much faster production is possible with specially-designed crankshaft machines, which have multiple burner and quench units, designed to deal with several surfaces simultaneously, the burners for heating the crankpins being traversed in the same rotary path as the pin surfaces by means of a master crankshaft in the machine.

Another special application of the Peddinghaus process, for straight-line work this time, is in the hardening of railway crossing surfaces. Pre-heating burners are used to raise the temperature of the rail surface progressively until the final burner and quench unit, under the control of a Milliscope, carry out the actual hardening.

Production

A NEW WORKS FOR HEAVY CONSTRUCTION

A special feature of Ashmore, Benson, Pease and Company's new works is the light machine shop, which has been designed to give a very large clear working area, but where the overhead crane system allows a load to be lifted from any one point to any other. The new works are only half a mile from the old in Stockton-on-Tees, but are on a site which gives ample room for expansion.



An uninterrupted floor area 400 ft by 170 ft is provided in the light machine bay by using portal frames pin-jointed at their bases.

An important characteristic of the work done by the Power-Gas Corporation Limited and their associate Ashmore, Benson, Pease and Company, Stockton-on-Tees, is its great variety. The group designs, manufactures and erects plant and equipment for the chemical, petroleum, gas, nuclear energy, iron making and edible oils industries, and the organisation is arranged in divisions dealing with each particular type of plant.

In addition to the chemical, gas, petroleum and blast furnace divisions, the names of which are self-explanatory, there are a works and a general contracts division, the former dealing with the manufacture of all classes of pressure vessels, heat exchangers and other welded fabrications, and the latter being concerned with project engineering from design to operation, field engineering and contract services, and gasworks equipment. Machinery for the oils and fats industry is made by the group's associate, Rose, Downs and Thompson Limited, Hull.

The variety of products made at the main works at Stockton-on-Tees is thus very large indeed. Ten years ago it was foreseen that the products were likely to increase in size, that they would be required to meet closer tolerances and still higher standards of quality, and that new materials of construction would be involved on an increasing scale. It was therefore decided to rebuild the works progressively over a period of years on a new site, to meet all foreseeable requirements. Today, the new South Works—on a virgin site about half a mile from the original plant—are in full operation. They are fully self-contained except for the foundry and pattern shop, which remain on the old site.

EXPANSION

The South Works site covers 125 acres, of which about 40 acres have been developed up to the present, so there is ample room for future extensions. Accessible by road from two sides, and with rail siding connection to the main line of British Railways, the new works are divided into two main sections, a constructional shop and a building housing the light, medium and heavy machine shops. A certain amount of assembly is carried out in both sections of the works though, of course, much of the heavy equipment produced can only be trial assembled in part at Stockton and is finally assembled on site. A steel stockyard, with a rail siding and overhead cranes, extends across the ends of both sections of the works, and steel is moved into the shops by electrically propelled transfer cars.

The constructional shop has a covered area of 200,000 sq. ft, made up of two bays each 65 ft wide and 520 ft long, with crane tracks 50 ft above floor level, and six connecting transverse bays each 85 ft wide, 250 ft long and 30 ft high to the crane tracks. Sixteen overhead cranes serve the shop, and the lower crane tracks, in the transverse bays, are cantilevered into the high bays, so that work in progress can be transferred to any point as required. Overhead cranes with capacities of 10, 15, 20 and 50 tons serve the whole area, and at the sub-assembly points there are jib cranes of up to 2 tons capacity.

Equipment is provided for shearing, cropping, plate-edge planing, flame cutting (including edge preparation up to 40 ft by 10 ft by 4 in thick), plate forming (by roll and press), drilling and welding. Manual welding equipment provides for acetylene, metal arc and inert gas shielded non-consumable electrode work, semi-automatic plant allows for inert gas shielded consumable electrode welding, and automatic equipment covers Fusarc, Fusarc CO_2 and submerged arc operation. Single welded fabrications can be made up to 100 tons in weight, and the shop is equipped to meet the requirements of all classification and inspection authorities. A four-zone single-ended furnace, 20 ft wide by 20 ft high by 50 ft long, with a flat topped charging bogie capable of carrying 100 tons, is installed for stress relieving.

A structural shop, of 27,200 sq. ft, adjoins the main fabrication shop. General structural work for all branches of the company's activities occupies this shop. A small annex to the structural shop deals with light fabrication such as gas mains and ducting, and undertakes the preparation of templates.

MACHINING

The machine shops are separated from the constructional shops by a bay housing the shop services and the X-ray and test rooms. They have a total area of 150,000 sq. ft and are divided into three sections, housing heavy, medium and light machining respectively. A floor area of 40,000 sq. ft is occupied by the heavy section, and eight large machine tools, with an installed horse-power of 597, give facilities for machining single pieces up to 100 tons in weight.

Of particular interest are a Berthiez vertical borer taking up to 20 ft 8 in diameter by 11 ft, a Butler planer of 35 ft stroke and 8 ft 1 in by 10 ft 3 in work capacity, and a faceplate lathe capable of swinging up to 34 ft diameter on the

faceplate, or 11 ft 4 in diameter and 50 ft long between centres. As no suitable machine could be purchased for delivery in the time required, Ashmore, Benson, Pease and Company designed and built this lathe themselves. Two 50 ton overhead cranes span the heavy machinery area, and a 15 ton semi-goliath crane is installed at one end of the shop for assembly purposes; about a third of the area is occupied by assembly.

Medium machining and assembly cover an area of 40,000 sq. ft, about half this space being devoted to assembly. Nine machine tools with an installed horse-power of 336 cover all normal machining such as turning, boring, milling, planing and drilling, the largest single item dealt with being 35 tons in weight. This section is parallel with the heavy bay, and machined parts and assemblies can be fed across to the heavy section for further assembly with large components if required. Rail tracks in the medium bay allow for the assembly, test, and dispatch of such equipment as iron and slag ladles, as well as rail dispatch of other finished products.

LIGHT MACHINING

All machining and assembly work from the smallest to individual weights of 5 tons is carried out in the third of the sections, a 70,000 sq. ft shop which has several unusual features. By using portal frames of open construction, pin-jointed at their bases, the designers have provided a working floor 400 ft by 170 ft completely free from obstruction. This unsupported span of 170 ft carries nine 5 ton overhead cranes, of unique design. There are four independent crane tracks, and all the cranes can be used in the normal way to traverse the length of the track. In addition, the cranes on adjacent tracks can be aligned and latched together, so that the crab can travel from one track to another. Loads can thus be transferred from any point in the shop to any other point, without lowering and re-slinging, while at the same time the separate tracks can be used as desired. One of the cranes is fitted with cab control, while the others have pendant push-button controls at floor level. All these floor-controlled cranes are designed to allow for operators' cabs to be added at a later date if required.

Fifty-one machine tools with an installed horse-power of 616 are spread over about seven-eighths of the shop; the remaining part is used for assembly purposes. Provision is made for all normal machining operations, and a section of the shop is equipped as a toolroom, with full facilities for tool maintenance, including heat treatment.

FEWER INDUSTRIAL ACCIDENTS

Resulting from a 4 per cent decrease in the number of factory accidents in 1958, the Chief Inspector of Factories was able to announce the lowest accident level for 23 years in a report published on 29 July. The number reported fell from 174,713 in 1957 to 167,697 in 1958. After congratulating industry on "a further achievement," the Chief Inspector said that the figures were still too high and that safety must be the continuing concern of everyone from the managing director down to the youngest apprentice.

In spite of the overall improvement, there were some categories which showed a rise. For the second year in succession there was an increased number of accidents associated with the use of power presses, although great efforts had been made to produce improved designs and methods of guarding. In this context, the report expressed disappointment and pointed out the need for greater effort, particularly in the maintenance of machines and their guards.

Other categories which showed a rise were fires, electricity, and transport (excluding the classes which involve locomotives and hand trunks, bogies, etc.) £13½ million were estimated to have been lost in 7,000 outbreaks of fire. Of these 7,000 outbreaks, 80 accounted for half the total loss.

Together with the main report is published a second concerning industrial health, which this year includes two special chapters on occupational cancer and the report of a survey carried out on medical supervision in 210 factories. There is also a comprehensive chapter on industrial diseases, poisoning and gassing. Both reports are obtainable from HM Stationery Office.

MANUFACTURERS' STOCKS STILL LOW

Although stocks tend to increase in the opening months of the year (and this happened even in 1958) there was little sign of it happening in the first quarter of 1959. Earlier estimates have now been confirmed by the Board of Trade that most manufacturers seemed to be pursuing a policy of restraint in stock building. In the largest category, which consists of engineering and metal forming, the official figures show that there was a slight reduction of 0·1 per cent in the value of stocks held in the first three months of the year. This followed a similar slight decline in the previous quarter. The engineering industry is the largest holder of stocks in manufacturing industry and it will not be until the engineering industry starts to rebuild its stocks with greater confidence that some sections of the basic industries and certain component manufacturers will be clear of the recession.

MORE FACTORY SPACE WANTED

In the second quarter of 1959 there was a sharp increase in the number of new factory approvals by the Board of Trade. Six hundred and fifteen certificates were issued compared with 527 in the previous quarter and with 503 in the second quarter of last year. At 14·1 million sq. ft the area approved is 10 per cent higher than last quarter when the figures were in any case somewhat inflated by the inclusion of the new steel strip mill at Newport. At present activity in the building industry is being maintained largely by housing and public works. The recovery in plans approved by the Board of Trade suggests that industrial building will have improved significantly by the end of the year.

SCOTLAND'S STRIP MILL

Further details have been published about the new steel strip mill to be erected in Lanarkshire including some general statistics. Production is due to begin at the new works towards the end of 1962. Initial capacity, as already published, will be 500,000 tons a year, consisting of 250,000 tons of light plate and 250,000 tons of sheet.

The potential capacity of the semi-continuous hot strip mill is 1·5 million tons a year. New jobs directly created by the project for steel workers are estimated at 1,500. In addition it is confidently anticipated that between 500 and 600 men will be moved over from hand sheet mills to work in the new undertaking.

Marketing

Chinks in the Curtain

Announcements of orders placed in the Western Hemisphere by Russia, China and other Iron Curtain countries are becoming more frequent. Even American firms are showing interest. A group of ten United States executives, including a vice-president of Westinghouse Electric Corporation, recently toured Soviet electric power systems and equipment manufacturing plants. The trip was conducted under the auspices of the US Department of State and was sponsored by the Edison Electric Institute and the Association of Edison Illuminating Companies, trade associations of United States electric utility companies. An IBM 305 RAMAC computer was shown at the American National Exhibition in Moscow and its disc memory used to put over the American way of life to the Russian public.

Orders for British products include one for airborne navigation equipment ordered by Aeroflot from Standard Telephones and Cables; nine pulp steeping presses and two fibre-baling presses to be built by Fawcett Preston for the rayon plant which Courtaulds are building for Russia; nucleonic equipment sold by Ekco Electronics to China; spinning machinery to the value of £250,000 ordered by the Polish textile industry from Prince-Smith and Stells; and some twenty electric locomotives and overhead line equipment (worth £2¾ million) ordered by the Polish agency Elektrim from BICC, English Electric and Metropolitan-Vickers. This order was based on long-term credit. More will follow, but the ability of British firms to grant credit terms is greater than has been their practice so far.

Reasons for Failure

Some of the more important reasons why British firms have their bids rejected by the International Cooperation Administration were listed in a recent Board of Trade circular. Most of them consist of non-compliance with the stated conditions of the invitation to tender. These include: failure to quote all prices in US dollars; submission of merely one quotation for the total of all items instead of quoting prices for each individual item in a tender, where applicable; failure to undertake delivery within the time specified; refusal to promise that the goods supplied will be marked with the correct ICA symbols; failure to accept the payment terms indicated in the bid invitations and objections to the special and general conditions stipulated with the invitation to bid.

The moral is an easy one: tender on the lines indicated or not at all. To do otherwise is a waste of time.

Catalogue in Arabic

The use of electricity in Arabic-speaking countries has grown so much in recent years that the General Electric Company have produced a catalogue in Arabic. It is in the form of a handbook, and sets out as simply as possible the a.b.c. of electrification. For example, it explains what earthing a circuit means, how to wire a house and other simple tasks which in their countries have to be carried out by relatively very inexperience dpeople. The Arabic-speaking countries have begun to build up a number of small electrical contractors, who, GEC say, "are not highly trained men and will need all the information and help they can get."

The material was written in the simplest English possible and translated by a man who also knew something about electricity and could turn the technical terms into understandable Arabic. Where necessary line drawings have been added to make descriptions absolutely clear and unmistakable. Finally the catalogue was set in Arabic and printed on a special,

tough paper so that it will stand the rough treatment it will probably get on the job. The catalogue includes details of some products for which there is a ready market in the areas concerned, such as street lighting, radios, domestic equipment and electro-medical equipment.

British Radar Exports

The penetration of world export markets by Decca Radar Limited continues. In July they received an order worth $106,000 for the fitting of 23 radars from the City of New York Ferry Services. This brings to 37 the total of Decca radars exported to New York. This month they obtained a contract for a big radar station for Maiqueta, Caracas' international airport. The order, which was placed by the Ministry of Communications of Venezuela, was awarded " in open international tender after very stiff competition from United States companies." The new equipment is designed to solve the problem of operating jet aircraft in high traffic densities, for which it is being fitted extensively in Sweden. Decca's success reflects the lead that British radar designers have built up since the war.

A Company in France

An account of the types of representation available in France, together with guidance on legal points and on the various methods by which United Kingdom exporters may find agents in France are contained in a report published by the Export Services Branch of the Board of Trade. An attempt is made to summarise all essential regulations but " because of the intricacies of French Commercial law " a list of British lawyers practising in Paris is appended to enable exporters to obtain precise information on their own particular problems. This report should be read in conjunction with another entitled " Forming a Company in France " which contains basic information on company law, taxation, labour costs, light engineering, wages, etc. These two reports, which have been prepared by the Commercial Section of the British Embassy, are available on request from Exports Services Branch, Theobalds Road, London, WC1.

Selling by Night

Showrooms which continue to operate after the sales staff have left were opened last week in Bournemouth by George Hartwell Limited, who are members of the Robins and Day Group, the Rootes main agents, who have 22 sales and service depots in the South of England. Performing the opening ceremony Mr. Brian Rootes described it as " a new idea in selling." The front showrooms remain open and lit during the night and a hidden voice describes the cars and details as to price, accessories, etc., while the customer walks round and inspects the models.

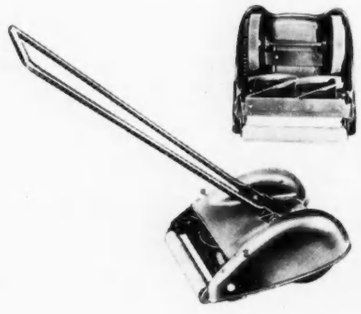
This method of projecting sales talk late into the night may well prove to successful promotion for goods other than motor cars. It helps to overcome the problem of staffing showrooms in the evening when many customers have time to look round. There will, however, be no one to conclude the sale: the voice cannot be a substitute for the salesman.

At Home

OUTDOORS

Engineering is playing an ever bigger part in the garden as a result of the still increasing popularity of power operated tools. These have developed mainly along the lines of a motor unit with many attachments for different purposes, some of them quite a long way removed from basic gardening.

Typical of these tools is the Gardenmaster, made by Landmaster Limited. The smaller model, the 34, is primarily a rotary cultivator for the small mixed garden. It is driven by a ¾ h.p. two-stroke engine and is propelled by the digging blades. Included with the basic machine is a spin weeder which twists the weeds out. Attachments include pick tines for compacted soil, a hedge trimmer and a cylinder lawn mower with a 12 in cut. All attachments can be changed without the use of tools. Another item is a water pump which will deliver approximately 1,000 gallons per hour at full throttle. A larger size of basic unit, the 80, has a 1½ h.p. engine and can be used with all the above mentioned attachments and also with a rotary rough grass cutter, a rotary lawn mower and a range of commercial



growers' equipment. Attachments for other machines number among them a circular saw and an insecticide spray.

The Ransome Conquest mower illustrated above has been designed to overcome one special difficulty encountered in cutting lawns, namely, the edge strip. For this reason the wheels run in front of the cutting cylinder so that the blades overlap the wheel tracks giving a cut the full width of the machine. It is therefore possible to cut the edge of the lawn and so avoid the tedious business of going round afterwards with the shears.

The shell of the mower acts as a shield as well as a chassis and has the additional task of pushing aside flowers that overhang the border. It also guards the six blade cutter from fingers. A lightweight collapsible grass box, made of canvas on a frame, can be fitted to the machine. No lubrication is needed for the cutter cylinder as it runs in sealed ball bearings.

The traditional cast iron drain pipe and guttering has been challenged of late first by aluminium and more recently by plastics and other materials. Aluminium as a material of construction offers several advantages in climates where corrosion risks are high, as well as being inherently lighter than cast iron. It requires no painting for its protection as the film of oxide formed is impervious and is naturally harder than the pure metal.

Pitch fibre has been in use in America for some time but has only recently been approved in this country (in some places) for drain pipes. They are made of a fibrous material, in some cases asbestos, bonded with pitch to give a very light and comparatively inexpensive system of piping. They lack the rigidity of metal pipes, however, and therefore care should be taken when laying them in the ground to see that they lie flat and are not crushed by the overfill. They are intended to carry domestic drainage and as such conform to BS2760. They have also been used to carry some trade effluents with success. Both the Key Engineering Company and the Universal Asbestos Manufacturing Company make a complete range of sections and fitments for use as fall pipes, internal stack drainage, sewerage pipes and also for under floor ducting in buildings. Pitch fibre pipes are light to handle, completely non-corrosive to acids, do not rot in the ground, can be cut by hand and are jointed by cone ends or by a sealing compound.

More recently still, Unity Structures have announced the introduction of a range of fall pipes and guttering made of ICI's Weldvic polyvinyl chloride, which is tough, weather resistant and non-corrosive. They are integrally coloured and therefore never need painting, with a consequent reduction in house maintenance. Lightness and ease of fitting should be others of their attributes.

An old-time material is coming back into use: copper for roofing. The decorative value of the green patina was used by many architects of generations ago, and it now seems possible that it will appear again. Two firms, Ruberoid and Marsland and Company, are marketing the material but in rather different forms.

Ruberoid advertise a roofing material of a lamination of copper sheeting and a glass fibre based bitumen. It is claimed that the result of firmly laminating the materials in a single sheet combines all the outstanding weatherproofing qualities of bitumen roofing with the best features, including the characteristic appearance, of the copper roof. All laps, flashings and aprons will be fully sealed by the underlying reinforced glass fibre based roofing. The copper sheet has an indentated finish which, as well as giving a good appearance, acts as an expansion joint. Side joints may be lapped flat or produced as standing seams or batten rolls. End joints are lapped flat to avoid obstruction to the water run off. Flat roofs should have falls of not less than 1° (2 in in 10ft).

On the other hand, Marsland are offering copper tiles consisting of pure copper sheet formed and welted round a high grade crossboard plywood which is proof against boiling water. The plywood has also been impregnated against woodworm and infestation. The tiles measure 12½ in square and weigh 1·3 lb per sq. ft so allowing a lightweight timbering. They are fixed by a flat head copper nail at one corner which is covered by the overlap of the sheet copper surface. Particular claims are that once fixed the tiling cannot slip or fracture and requires no maintenance. The tiles can be used for any roof pitch not less than 18°.

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